Appendix I: Technical Reports

The following technical reports are included on the Volume 1 DVD.

Technical Reports in Appendix I
Air Quality Technical Report
Alternatives Technical Report - 2012 Update
Bus Operations Plan Technical Report
Environmental Justice Technical Report
Indirect and Cumulative Effects Analysis Technical Report
Natural Resources Technical Report
Noise and Vibration Technical Report
Operating Plan Technical Report
Purpose and Need Technical Report
Public Involvement Technical Report
Section 106 Assessment of Effects for Built Historic Properties
Travel Forecast Results Report
Traffic and Parking Technical Report

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION

MARYLAND TRANSIT ADMINISTRATION

Baltimore, Maryland

Baltimore Red Line

Red Line General Engineering Consultant

Bus Operations Plan Technical Report
December 2012

Document No.
1726

Table of Contents

1. Introduction

This report describes the physical and operational changes proposed for the feeder bus network within the Red Line project study corridor. It outlines the modifications to bus services that terminate at, and pass through, each Red Line Preferred Alternative station. It also identifies the locations where buses either terminate or travel through a proposed station.

1.1 Project History

The 2002 *Baltimore Regional Rail System Plan* recommended a 109-mile Regional Rail System with 66 new miles added to the existing 43 miles of Metro Subway and Central Light Rail lines. The finished system could have as many as 122 stations, including 68 new stations in addition to the 54 stations that exist now. The Red Line project was identified as one of the priority projects for the Plan's implementation. In 2003, the Federal Transit Administration (FTA) issued a Notice of Intent (NOI) to prepare a Draft Environmental Impact Statement (DEIS). Scoping and alternatives development followed and, based on public and agency input, the FTA and Maryland Transit Administration (MTA) developed a range of alternatives for consideration in the alternatives screening process. Between 2005 and 2007, the FTA and MTA conducted an alternatives screening process, which was intended to identify a range of alternatives for detailed study in the Alternative Analysis/Draft Environmental Impact Statement (AA/DEIS). The 2008 AA/DEIS studied in detail four alternatives: No-Build, Transportation Systems Management (TSM), Bus Rapid Transit (BRT), and Light Rail Transit (LRT). The AA/DEIS was made available for public and agency review between October 3, 2008 and January 5, 2009. The AA/DEIS did not identify a Preferred Alternative; however, the FTA New Starts Process requires the local project sponsor to identify a Locally Preferred Alternative (LPA). In August 2009, the State of Maryland, with consensus from Baltimore City and Baltimore County, identified a 14.5-mile LRT alignment from the Centers for Medicare & Medicaid Services (CMS) to Johns Hopkins Bayview Medical Center campus with tunnel alignments under Cooks Lane and through downtown from Martin Luther King, Jr. Boulevard to Boston Street. Since then, the MTA has conducted technical studies, refined the LPA, and continued the public involvement and agency coordination, including the Station Area Advisory Committees (SAACs). The results of these studies and definition of the Preferred Alternative are presented in the Final Environmental Impact Statement (FEIS) and supporting technical reports. The Preferred Alternative is a 14.1-mile LRT line that would operate from the CMS in Baltimore County to the Johns Hopkins Bayview Medical Center campus in Baltimore City (**Figure 1**).

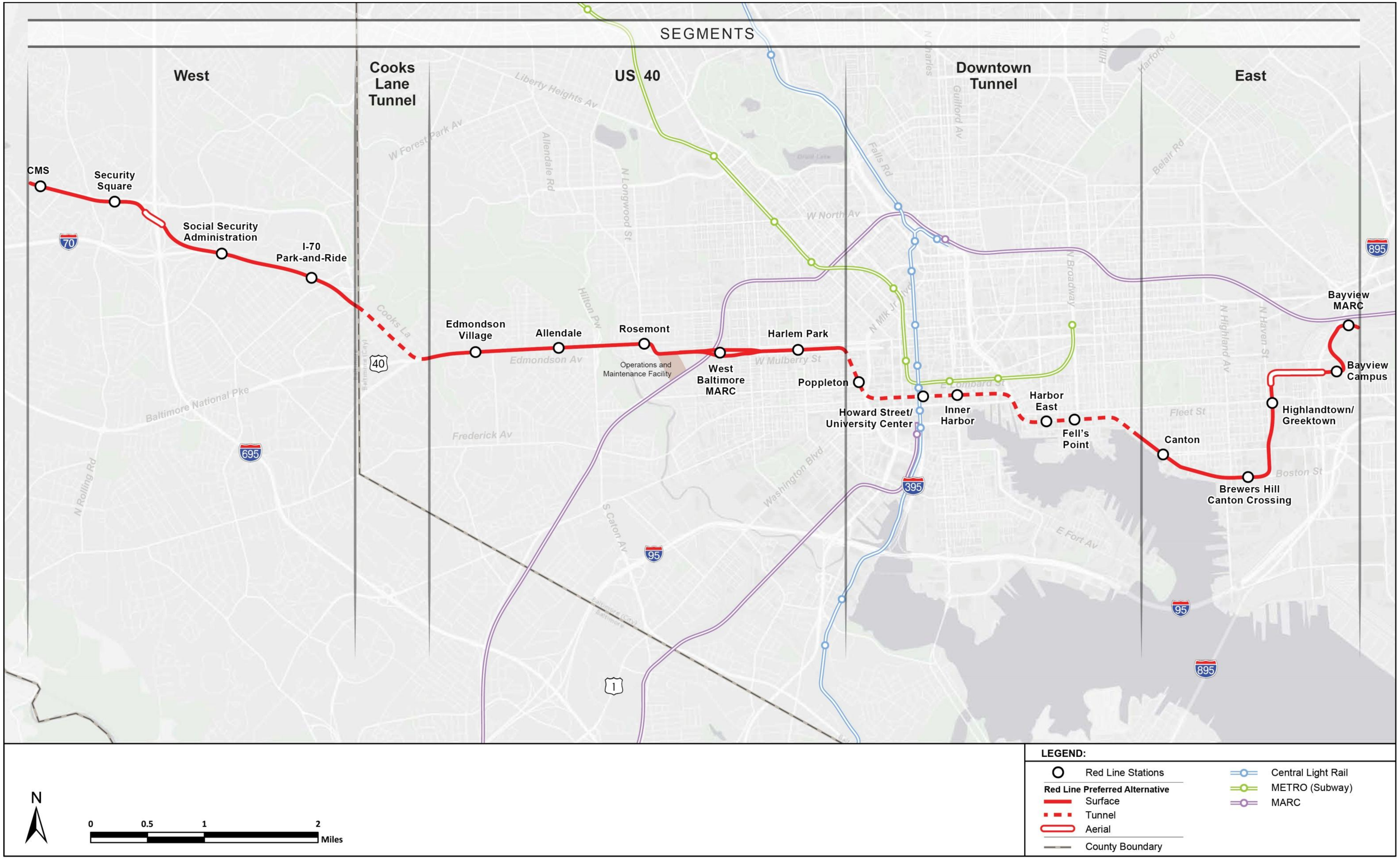


Figure 1: Red Line Preferred Alternative

2. Feeder Bus Vehicles and Operations

The MTA operates bus service in Baltimore City, and Anne Arundel and Baltimore Counties, using a variety of vehicles depending on the application. **Table 1** identifies bus vehicle characteristics and applications. The Red Line project study corridor only includes Baltimore City and Baltimore County.

Table 1: Bus Vehicle Characteristics

	Seats	Length	Application
Standard	43	40 feet	Typical for many bus routes
Standard – low floor	36	40 feet	Typical for many local routes
Articulated	63	60 feet	Provides additional capacity on higher ridership local and limited routes or selected limited and express trips
Regional	55	40-45 feet	Typical for regional long-distance routes
Medium	29	29-30 feet	Used on lower to moderate ridership local routes or in areas where a larger bus cannot readily maneuver

Vehicle capacity, the total number of seated and standing passengers, is a function of available floor space and seating capacity and configuration. The loading standards policy defines the loading capacity. The loading standards policy is determined based on the type of vehicle, the type of service and the number of persons per square foot assumed for average and crush loading.

Loading standards are expressed as a function of seating capacity, typically referred to as load factor. A load factor of 1.0, reflecting a capacity equivalent to the total number of seats, applies during all times except peak periods. A load factor of 1.25 indicates a capacity that is 25 percent greater than the seated load, or 25 percent standees. Peak period load factors are greater than 1.0, but vary by vehicle type, the number of seats and standing space, and the type of service being operated. For example, high-speed express services, where standing is unsafe, often have a lower load factor than local bus routes operating slowly on city streets, on which standing is relatively safe.[1]

Peak loading standards apply to trips that occur within the peak one-hour or during the peak period. Individual trips may surpass the standard provided the overall average for the hour or period is within stated standards. **Table 2** notes the loading standards for buses by service type.

[1] The number of standees is based on the available space in a transit vehicle and a total amount of space for each individual. For peak periods, standee space equals 3.2 ft^2 per passenger (3.3 passenger/m^2). The loading standard for special events allows for more standees and is based on 2.15 ft^2 per passenger (5 passengers/m^2). No limit is placed on the maximum time an individual passenger may have to stand for a special event trip.

Table 2: Loading Standards by Service Type

Service Type	Load Factor	
	Peak	Off-Peak
Local and Limited Bus	1.5	1
Express and Regional Bus	1	1

The total seating and standing capacity based on loading standards varies by vehicle type. Application of the above peak standards to the vehicle types listed in **Table 1** results in total passenger capacity per vehicle, a basis for determining vehicle fleet. **Table 3** shows capacity by vehicle type. The values noted for light rail vehicles are subject to change based on the final vehicle configuration, which would be determined in the specification and procurement process.

Table 3: Capacity by Vehicle Type – Peak Service

Service Type	Seats	Load Factor	Total Capacity
Standard Bus	43	1.5	60
Articulated Bus	63	1.5	90
Regional Bus	55	1	55
Medium Bus	29	1.5	45

2.1 Feeder Bus Fares

All feeder bus routes in the project study corridor would operate as local service and charge the standard local fare, except for commuter express routes designated as three digit routes. Feeder buses from park-and-ride lots in Howard County and eastern Baltimore County would operate as express routes. **Table 4** shows the fares for these different service types.

Table 4: Local, Shuttle, and Express Bus Fares

Service Type	Zone	One-Way Cash Fare		Day Pass		Weekly Pass	Monthly Pass	
		Full Fare	Sr./Dis.	Full Fare	Sr./Dis.		Full Fare	Sr./Dis.
Regular	Base	$1.60	$0.55/ride	$3.50	$1.20	$16.50	$64.00	$16.50
Shuttle	Base	$1.00	$0.50/ride	$3.50	$1.20	$16.50	$64.00	$16.50
Express	Base	$2.00	$0.95/ride	$3.50 + $0.40/ride	$1.20 + $0.40/ride	$16.50 + $0.40/ride	$80.00	$16.50 + $0.40/ride

Notes: Regular fares apply to Bus Routes 1 through 99 and Quick Bus Routes 40, 46, 47, and 48.
Shuttle fares apply to Hampden and Mondawmin Metro Shuttle Bus routes.
Express fares apply to Bus Routes 104, 120, 150, and 160 and express trips operated on regular routes

3. Existing Red Line Corridor Bus Service

There is a high density of existing transit services within the project study corridor. Twenty-three bus routes (Routes #1, 7, 10, 11, 13, 15, 16, 20, 21, 22, 23, 24, 30, 38, 40, 44, 47, 51, 57, 77, 99, 150, and 160) provide bus service and serve over 131,600 riders per day. These 23 routes (shown in **Figure 2**) do not include other MTA bus routes that cross through downtown perpendicular to the Red Line. Four of the 23 routes (15, 20, 23, and 40) are among the highest ridership bus routes in the MTA bus network. Because of the large number of existing bus routes, the majority of the routes in the feeder bus network required to serve the Red Line Preferred Alternative are already in place. Minor modifications to existing route alignments are proposed to allow them to serve Red Line Preferred Alternative stations. **Table 5** summarizes the existing bus service characteristics for the 23 routes.

While the project study corridor contains an extensive bus network serving east-west travel, bus service can be slow. Buses operate on local streets, which are subject to the same traffic signals and traffic congestion as other vehicles. The fact that ridership is high in the project study corridor despite slow speeds emphasizes the strong transit market in this corridor.

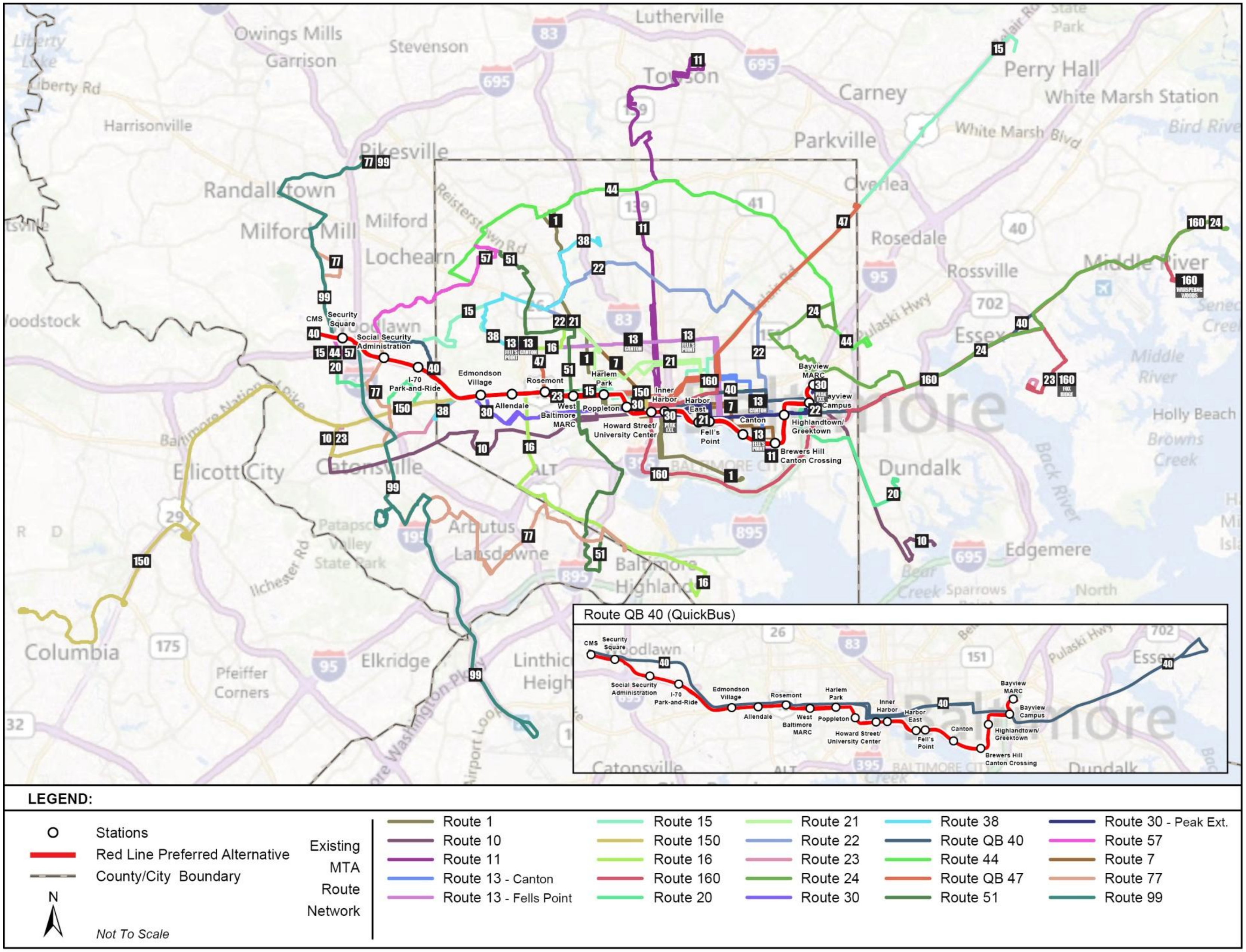


Figure 2: Current Alignments of MTA Routes Affected by Red Line Preferred Alternative

Table 5: Existing Bus Service in Project Study Corridor

Route	Northern/ Western Terminus	Southern/ Eastern Terminus	AM Peak	Mid-Day	PM Peak
			Headways	Headways	Headways
1	Sinai Hospital	Fort McHenry	15 min	30/60 min	15 min
7	Mondawmin Mall	Canton	30 min	50 min	30 min
10	US 40 and Rolling Road	Dundalk	15 min	30/60 min	15 min
11	Towson Town Center	Canton	20/30 min	30/60 min	20/30 min
13	Walbrook Junction	Canton	10 min	20/60 min	10 min
15	Security Square Mall	Perry Hall	12/15 min	20/30 min	12/15 min
16	Mondawmin Mall	Brooklyn Homes	20 min	60 min	20 min
20	Security Square Mall/CMS	Dundalk	15 min	30/60 min	15 min
21	Mondawmin Mall	Fell's Point	20 min	45/60 min	20 min
22	Mondawmin Mall	Bayview	10-15 min	50 min	10-15 min
23	US 40 and Rolling Road	Fox Ridge	15 min	20/60 min	15 min
24	Moravia Park	Whispering Woods	15 min	30 min	15 min
30	Edmondson Village	Bayview	15 min	20 min	15 min
38	North Bend	Cold Spring/Grandview	10 min	N/A	10 min
40	Security Square Mall	Middle River	15 min	15/30 min	15 min
44	Security Square Mall	Rosedale Industrial Park	15/20 min	30/60 min	15/20 min
47	Walbrook Junction	Overlea Loop	15 min	N/A	15 min
51	Rogers Avenue Metro Station	Patapsco LRT Station (Baltimore LRT)	15-20 min	40 min	15-20 min
57	Rogers Avenue Metro Station	Security Square Mall	30 min	30/60 min	30 min
77	Old Court Metro Station	Patapsco LRT Station (Baltimore LRT)	30 min	60 min	30 min
99	Old Court Metro Station	BWI	30 min	N/A	30 min
150	Columbia	Downtown Baltimore	30 min	N/A	30 min
160	John Hopkins	Whispering Woods	15 min	N/A	15 min

4. Future Red Line Corridor Bus Service

This section describes proposed recommended changes to MTA bus service that would be implemented upon construction of the Preferred Alternative. The proposed changes detailed here have been designed for implementation of either the Preferred Alternative or the low-cost TSM bus alternative. While the assumption is the Preferred Alternative would ultimately be implemented, the TSM alternative is detailed at the end of this section.

The methodology for assessing and recommending changes to the bus network included the following four steps:

- Consideration of all MTA routes that would operate parallel to or interact with Red Line stations
- Consideration of existing travel demand patterns for these bus routes
- Analysis of travel demand changes expected to occur with construction of the Red Line project
- Recommended changes to bus alignment and frequency in order to serve these changed travel patterns

Once initial recommendations were made, they were presented to MTA Bus Operations, with subsequent revisions incorporating comments and recommendations from MTA. Many of the 23 existing bus routes parallel to the Preferred Alternative would be realigned to better serve LRT station locations, or undergo schedule changes to facilitate transfers or support expected ridership growth. As part of the realignments, 11 new bus routes would be added to provide service along core segments of existing bus lines. Some routes would experience an increase in service of feeder buses, whereas other routes may be shortened or eliminated because of this duplication. The changes that most affect bus trips occur at the stations because this is where the new and improved bus routes converge to “feed” the Red Line. These and other changes are summarized as follows:

- Portions of Route 40 Quick Bus would be eliminated. The eastern portion of this route’s alignment would be retained with local (L) and express (X) service options (40L and 40X);
- Bus routes 1, 7, 10, 11, 13, 15, 16, 20, 21, 22, 23, 24, 30, 38, 44, 47, 51, 57, 77, 99, 150, and 160 would connect with the proposed Preferred Alternative;
- New bus lines, 10 East, 10 West, 15B, 15 East, 15 West, 20 East, 20 West, 23 East, 23 West would be implemented to supplement existing bus service to meet projected demand for connections to/from the Preferred Alternative; and,
- The proposed new services are within the existing mobility service area and an expansion of them is not anticipated with the addition of the new bus lines.

As the Preferred Alternative continues to proceed through Preliminary Engineering and Final Design, proposed bus operations plans would be adjusted. In the two years prior to the estimated opening of the Preferred Alternative in 2021, the MTA would hold separate public hearings on proposed bus changes per MTA policy and it is expected that there would be continuous refinements to the bus operations plan until opening day.

The following section provides detailed descriptions of the proposed changes to feeder bus operations for each route. These are described further in **Table 6** and shown in **Figure 3**. Maps for each route change are shown in **Appendix A.**

Table 6: Red Line Project Feeder Bus Service Characteristics

Route	Northern/Western Terminus	Southern/Eastern Terminus	AM Peak Headways	Mid-Day Headways	PM Peak Headways
1	Sinai Hospital	Fort McHenry	15 min	30 min	15 min
7	Mondawmin Mall	Brewers Hill/Canton Crossing LRT Station	30 min	50 min	30 min
10	US 40 and Rolling Road	Dundalk	10 min	20 min	10 min
10E	Highlandtown/Greektown LRT Station	Dundalk	10 min	20 min	10 min
10W	US 40 and Rolling Road	Rosemont LRT Station	10 min	20 min	10 min
11	Towson Town Center	Harbor East LRT	20 min	30min	20 min
13	Walbrook Junction	Brewers Hill/Canton Crossing LRT Station	10 min	20min	10 min
15B	Walbrook Junction	Bayview Campus LRT Station	10 min	15 min	10 min
15E	Poppleton	Perry Hall	15 min	30 min	15 min
15W	Security Square LRT Station	Rosemont LRT Station	15 min	30 min	15 min
16	Mondawmin Mall	Brooklyn Homes	15 min	30 min	15 min
20	Security Square LRT Station	Dundalk	30 min	30 min	30 min
20E	Brewers Hill/Canton Crossing LRT Station	Dundalk	15 min	30 min	15 min
20W	Security Square LRT Station	West Baltimore MARC LRT Station	15 min	30 min	15 min
21	Mondawmin Mall	Harbor East LRT Station	20 min	45 min	20 min
22	Mondawmin Mall	Bayview Campus LRT Station	10-15min	50 min	10-15min
23	US 40 and Rolling Road	Fox Ridge	15 min	20 min	15 min
23E	Bayview Campus LRT Station	Essex	15 min	0 min	15 min

Table 6: Red Line Project Feeder Bus Service Characteristics

Route	Northern/Western Terminus	Southern/Eastern Terminus	AM Peak Headways	Mid-Day Headways	PM Peak Headways
23W	US 40 and Rolling Road	I-70 Park-and-Ride LRT Station	15 min	30 min	15 min
24	Moravia Park	Whispering Woods	15 min	30 min	15 min
30	I-70 Park-and-Ride LRT Station	Downtown Baltimore	15 min	20 min	15 min
38	North Bend	Cold Spring/Grandview	10 min	N/A	10 min
40L	West Baltimore Street and South Greene Street	Essex	15 min	30 min	15 min
40X	Bayview Campus LRT Station	Essex	30 min	N/A	30 min
44	Security Square Mall	Rosedale Industrial Park	15 min	30 min	15 min
47	Walbrook Junction	Overlea Loop	15 min	N/A	15 min
51	Rogers Avenue Metro Station	Patapsco LRT Station (Baltimore LRT)	15-20 min	40 min	15-20 min
57	Rogers Avenue Metro Station	Security Square LRT Station	30 min	40 min	30 min
77	Old Court Metro Station	Patapsco LRT Station (Baltimore LRT)	15 min	15 min	15 min
99	Old Court Metro Station	BWI	30 min	N/A	30 min
150	Columbia	I-70 Park-and-Ride LRT Station	20 min	N/A	20 min
160	Johns Hopkins Hospital	Fox Ridge/Oliver Beach	20 min	N/A	20 min

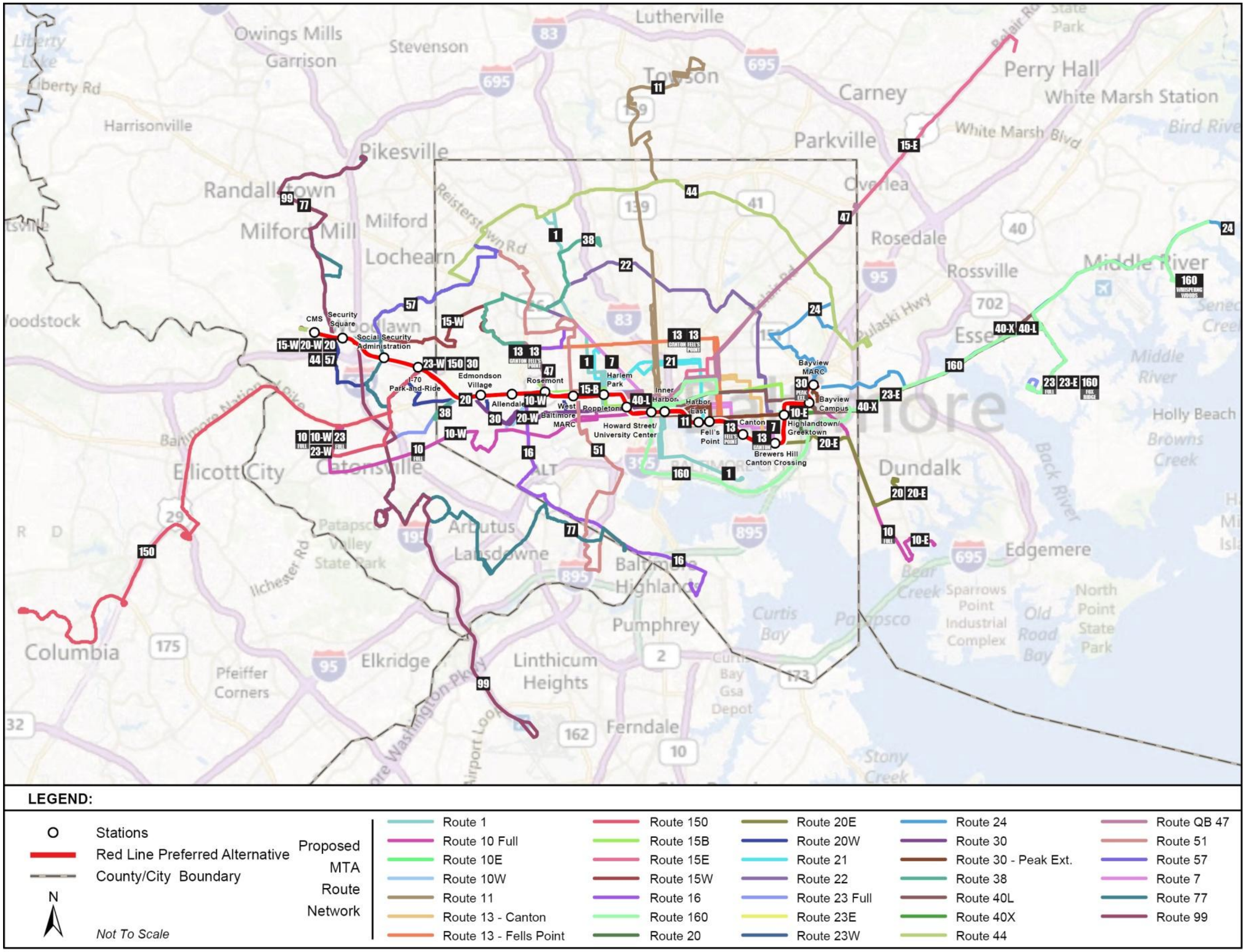


Figure 3: Proposed Alignments of MTA Routes Affected by Red Line Preferred Alternative

4.1 Route Description

- Route 1 would be unchanged upon completion of the Preferred Alternative. It would continue to operate as a north-south service and serve the Inner Harbor, Poppleton, and Harlem Park LRT stations as a through bus service.
- Route 7 would not have any schedule changes upon completion of the Preferred Alternative. It would continue to operate as an east-west service and serve the Inner Harbor and Howard Street/University Center LRT Stations. A small change to Route 7 is for the route to layover at the Brewers Hill/Canton Crossing Station instead of using the on-street loop it currently uses to turn around in this area.
- Route 10 would have two major changes. First, Route 10 would reduce its headways to 10 minutes during peak periods and 20 minutes off-peak. This route would continue to operate as a local bus line with the same span and terminals as it currently uses. It would connect to the Red Line at the Highlandtown/Greektown, Inner Harbor, Howard Street/University Center, and Poppleton Stations.

  The second major change is the addition of overlay feeder routes on the eastern and western ends of the route. These overlay feeder routes provide additional service to Red Line stations. Route 10E is a proposed feeder route between Dundalk and the Highlandtown/Greektown Station. It would utilize Dundalk Avenue and Eastern Avenue, with 10-minute peak and 20-minute off-peak headways. Route 10E would not operate on evenings and weekends.
- Route 10W is a proposed service created to feed the western portion of the Red Line. It would operate as an east-west route between US 40/Rolling Road and the Rosemont Station, its eastern terminus. The proposed routing for Route 10W includes Hilton Street to Culver Street, through Yale Heights to US 40 and then on to its western terminus.

  The route would operate with 10-minute peak and 20-minute off-peak headways, and would not operate on evenings and weekends.
- Route 11 would not include any schedule changes upon completion of the Preferred Alternative, but the alignment would truncate at the Harbor East Station because it parallels Red Line service through the Fell’s Point neighborhood. Route 11 would continue to use Towson Town Center as its northern terminus and serve the Red Line’s Inner Harbor and Howard Street/University Center Stations.
- Route 13 would have a small alignment change upon implementation of the Red Line. It would continue as an east-west route, serving the Canton and Brewers Hill/Canton Crossing Stations. However, Route 13 would layover at the Brewers Hill/Canton Crossing Station in the east, which is a small change from the on-street loop it currently uses to turn around. The route would continue to terminate at Walbrook Junction in the west.
- The current Route 15 would be eliminated and replaced with three route variations. Route 15E would use the same alignment as existing Route 15, but would terminate in the west at the Poppleton Station, with passengers transferring to the Red Line to continue traveling west. Route 15W would use the Route 15 alignment, starting at the

Rosemont Station and continue west to the CMS Station. The current Route 15 is very long and has trouble maintaining its schedule. Thus, this change would improve the performance of the bus route. The splitting of Route 15 is not expected to negatively impact passengers since the western terminus of the route is Security Square and CMS Stations, and it is likely passengers would be transferring to the Red Line anyway to access these destinations.

- The third variation is Route 15B, which would operate between Walbrook Junction and Bayview Campus Station with 10-minute peak and 15-minute off-peak headways. While this route would operate as a variation of Route 15, it would use Fayette Street/Pulaski Highway on the east side to Johns Hopkins Bayview Medical Center campus, not Gay Street/Belair Road like the current Route 15 and proposed Route 15E. This route would provide additional east-west service on the eastern side of the city.
- The alignment of Route 16 would not change upon completion of the Red Line. Its headway would increase from 20-minutes peak and 60-minutes off-peak to 15-minutes peak and 30-minutes off-peak. This change would provide more service for transfers to the Red Line at the Rosemont Station.
- Route 20 would have both schedule and alignment changes with the opening of the Red Line. The alignment changes are on the east and west ends of the route. At the western terminus, Route 20 would first serve the CMS Station, and then turn around at a roundabout at Security Blvd/Fairbrook Road to access its layover location at the Security Square Station. In the east, the route would use Bayview Boulevard instead of South Ponca Street in order to serve the Bayview Campus Station.
- Route 20 would also have headway changes during peak periods, from 15 to 30 minutes off-peak. The reduction of frequency is accompanied by overlay routes on the eastern and western ends of the route to provide additional frequency. Route 20W would operate between Security Square and West Baltimore MARC Stations at a headway of 15-minutes peak and 30-minutes off-peak. Route 20E would operate between Dundalk and Brewers Hill/Canton Crossing Station at 15-minute peak and 30-minute off-peak headway.
- Route 21 would be unchanged upon completion of the Red Line.
- Route 22 would not have any schedule changes upon completion of the Red Line, but it would use the Bayview MARC Station as its eastern layover/turnaround point. It would also serve the Red Line's Highlandtown/Greektown Station with through bus service.
- Route 23 would not experience any alignment or frequency changes upon completion of the Red Line. Two overlay routes would provide additional frequency on the eastern and western ends of the route to serve the Red Line. Route 23W would operate between the I-70 Park-and-Ride Station and US 40/Rolling Road, with 15-minute peak and 30-minute off-peak frequency. Route 23E would operate between Essex and Johns Hopkins Bayview Medical Center campus, with 15-minute peak period headway and no off-peak service.

- Route 24 would not have any schedule changes upon completion of the Red Line, but its alignment would change. Route 24 would use Lombard Street and I-895 rather than Erdman Avenue in order to access the Bayview MARC Station.
- Route 30 would extend from Edmondson Village to I-70 Park-and-Ride Station via Cooks Lane. The extension on Cooks Lane would replace local bus service from the eliminated Quickbus Route 40, and would provide a layover point for the route.
- Route 38 would be unchanged with completion of the Red Line.
- Quickbus Route 40 would be eliminated when the Red Line service is implemented, as the route parallels a large portion of the project study corridor. On the east side, two routes would replace service lost with the elimination of the Quickbus route. Route 40L would provide local service between Essex and downtown Baltimore primarily via Eastern Avenue with headway of 15-minutes peak and 30-minutes off-peak. Route 40X would provide service between Essex and the Bayview Campus Station during AM and PM peak periods with a headway of 30 minutes. Route 40X would have a limited stop operating pattern in order to expedite the trip for commuters.
- Route 44 includes a small alignment change upon completion of the Red Line. The line would still terminate at Security Square Mall, but would be extended to serve CMS on Security Boulevard. Westbound Route 44 would turnaround by using a roundabout at Security Boulevard and Fairbrook Drive to turn back east and layover at the Security Square Station. Service frequency and span would remain the same for the route.
- Route 47 would be unchanged with completion of the Red Line.
- Route 51 would be unchanged with completion of the Red Line.
- Route 57 would not have any service frequency changes upon completion of the Red Line, but would include a minor alignment change. Instead of laying over on the west side of Security Square Mall near Rolling Road, the route would instead lay over at the Security Square Station.
- Route 77 service frequencies would increase in order to feed the Red Line at Security Square and Social Security Administration (SSA) Stations. Headways are proposed to change from the current 30-minute peak and 60-minute off-peak to 15-minute peak and 15-minute off-peak.
- Route 150 would include both frequency and alignment changes upon completion of the Red Line. Heading east, the route would turn off US 40 and use Ingleside Avenue to terminate at the I-70 Park-and-Ride Station, rather than continuing to downtown Baltimore. Passengers would transfer to the Red Line to complete their trip downtown. Bus service on US 40 east from the point where Route 150 turns at Ingleside would still be provided by MTA routes 20, 23, and the Red Line, except for a 0.6-mile section between Ingleside Avenue and St. Agnes Lane.

- Headways would increase to every 20 minutes during peak periods. The route would not operate during off-peak periods.
- Route 160 would be unchanged with completion of the Red Line.

4.2 TSM Alternative

As noted in the beginning of this section, MTA bus network recommendations apply to both alternatives that remain in this stage of the project: the Red Line Preferred Alternative and the TSM low-cost alternative.

The TSM alternative recommends a new bus route, T1, to operate the same alignment as the Red Line light rail corridor, but all operations would be in mixed traffic and there would be no underground or aerial sections of the route. Route T1 would serve the same areas proposed for the Red Line project study corridor—operating between CMS and the Bayview MARC LRT stations—and provides transfers to all the routes that were proposed to feed the LRT stations in these areas.

In addition, Route T1 would operate at the same frequency as proposed for the Red Line rail service, with service frequencies every 7 minutes during peak hours and every 10 minutes during off-peak hours. However, because the T1 route would uses buses instead of light rail vehicles, the capacity of the line would be less than the Red Line even operating at the same frequencies.

As a result of these similar characteristics in alignment and frequency, the proposed bus network changes would apply to the TSM alternative the same as planned under the LRT alternative. Bus routes would feed the T1 bus route, rather than the Red Line, in the areas of the proposed rail stations. Quickbus route 40 would be eliminated, the same as planned in the Red Line alternative.

4.3 Station Description

The Preferred Alternative would include 19 stations, 14 surface and 5 underground, to provide access and connections to the light rail service. The proposed Red Line station locations have been identified based upon compatibility with surrounding site conditions, intended passenger catchment areas, site circulation, site services and amenities, transit oriented development opportunities, public space availability, future urban plan visioning, community input through the SAACs, and other public outreach.

The following section provides detailed information on how each bus route would interact with Red Line stations. **Table 7** summarizes the layover and infrastructure needs for each station. If private shuttles or other bus services would serve the stations, further analysis would be required to determine whether these additional vehicles can be accommodated at the stations.

4.3.1 Centers for Medicare & Medicaid Services (CMS) Station

Routes 15W, 20, 20W, and 44 serve the CMS station. Each of these routes are through routes at this station, turning around to the west at Security Boulevard/Fairbrook Road.

4.3.2 Security Square Station

Six bus routes (15W, 20, 20W, 44, 57, and 77) serve the Security Square Station. Five of the routes (15W, 20, 20W, 44, and 57) layover at the station and require bus bays. Route 77 is a through bus service and does not require additional infrastructure for its service at the station.

4.3.3 Social Security Administration (SSA) Station

Route 77 is the only bus route to serve the SSA Station. It serves the station as a through bus service and does not require additional infrastructure to serve the station.

4.3.4 I-70 Park-and-Ride Station

Three bus routes (23W, 30, and 150) serve the I-70 Park-and-Ride Station. Each of these routes layover at the station and require bus bays at the station.

4.3.5 Edmondson Village Station

Five bus routes (20, 20W, 23, 30, and 38) serve the Edmondson Village Station. Each operates as through service and requires no additional infrastructure at the station.

4.3.6 Allendale Station

Routes 23 and 38 serve the Allendale Station. Each of these routes operates as through bus service and do not require additional infrastructure.

4.3.7 Rosemont Station

Upon completion of the Red Line, six bus routes (10W, 15W, 16, 23, 38, and 47) would serve the Rosemont Station. Four of these routes are through routes (16, 23, 38, and 47) while two of the routes (10W and 15W) would turn around on-street near the station. No layover infrastructure is required at the station.

4.3.8 West Baltimore MARC Station

Four bus routes (20W, 23, 47, and 51) serve the West Baltimore MARC Station. Routes 23, 47 and 51 provide a through bus service and do not require additional infrastructure when serving the station. Route 20W turns around on local streets near the station but does not require infrastructure at the station.

4.3.9 Harlem Park Station

Two bus routes (1 and 23) serve this station. Both routes are through bus services, so no bus infrastructure is required at the station.

4.3.10 Poppleton Station

Five bus routes (1, 10, 15E, 20, and 30) serve the station but four of these (1, 10, 20, and 30) would stop on street as through routes and would not require additional bus infrastructure. Route 15E would turn around on local streets near the station.

4.3.11 Howard Street/University Center Station

Numerous bus routes cross downtown Baltimore and provide access to this station. The station is accessed as a walkup station. Buses stop on street, and no additional bus infrastructure is required.

4.3.12 Inner Harbor Station

Like the Howard Street/University Center Station, many bus routes cross downtown Baltimore and provide access to this station. The station is accessed as a walkup station, with no additional bus infrastructure.

4.3.13 Harbor East Station

Two routes provide service at the Harbor East Station, routes 11 and 21. Route 11 would turn around on local streets near the station. Route 21 currently has an on-street layover spot near the station and requires no additional bus infrastructure at the station.

4.3.14 Fell's Point Station

No bus service directly serves the Fell's Point Station.

4.3.15 Canton Station

Route 13 is the only bus route to serve the Canton Station. The route serves the station with through bus service and needs no additional bus infrastructure.

4.3.16 Brewers Hill/Canton Crossing Station

Three bus routes (7, 13 and 20E) serve the Canton Crossing Station. All three routes use the station as their layover/turnaround point and require bus bays at the station.

4.3.17 Highlandtown/Greektown

Three bus routes (10, 10E, and 22) serve the Greektown/Highlandtown Station. All routes serve the station as either through bus service or with an on-street turnaround and would not need additional infrastructure.

4.3.18 Bayview Campus Station

Seven bus routes (20, 22, 23, 23E, 30, 40L, and 40X) serve the Bayview Campus Station, although route 30 would only serve the station during peak periods. All routes are through routes or have an on-street turnaround, and the station would not require additional bus infrastructure.

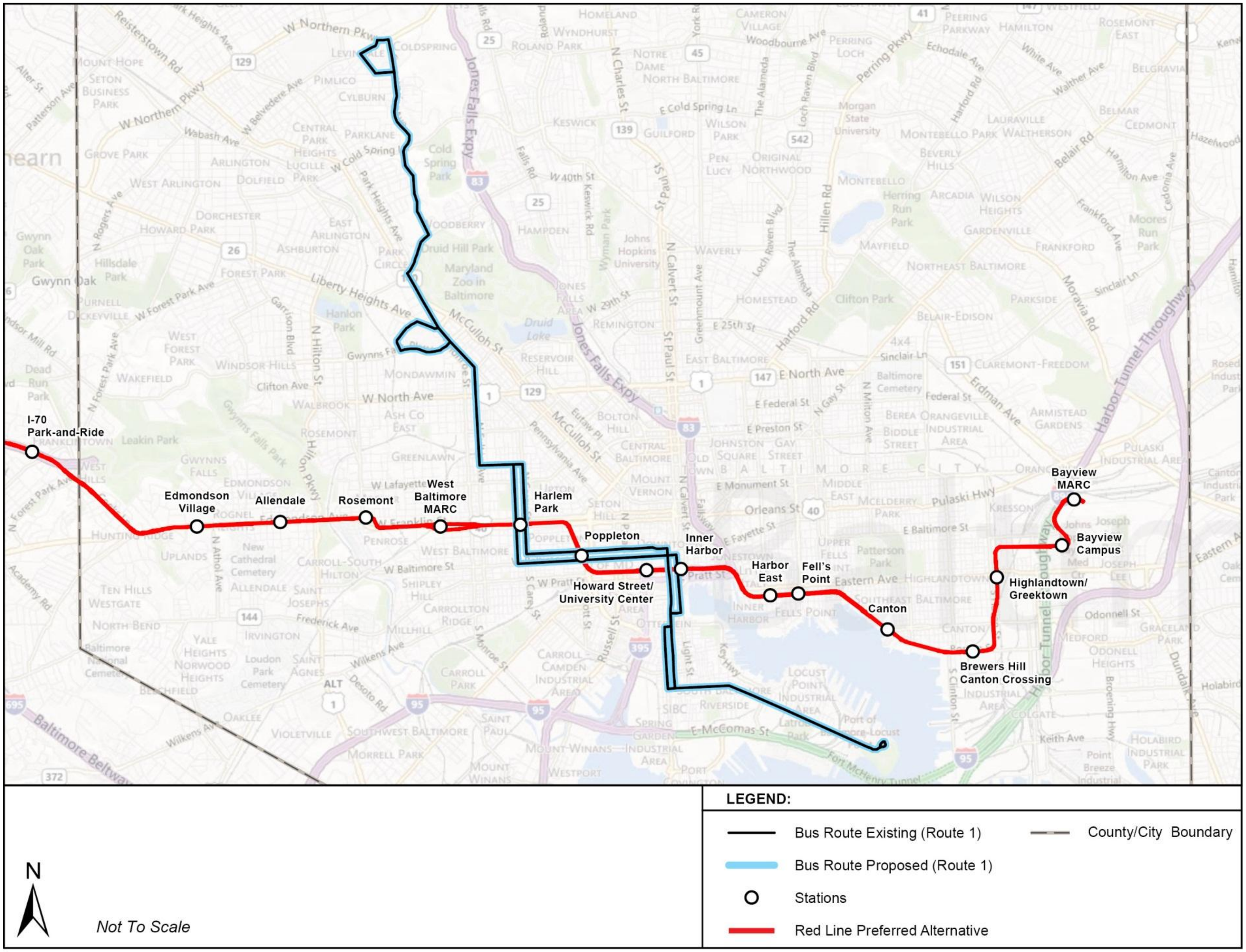
4.3.19 Bayview MARC Station

Two routes would serve the Bayview MARC Station (22 and 24). Route 22 uses the station as its turnover/layover point and requires a bus bay and turnaround loop. Route 24 serves the station as a through route.

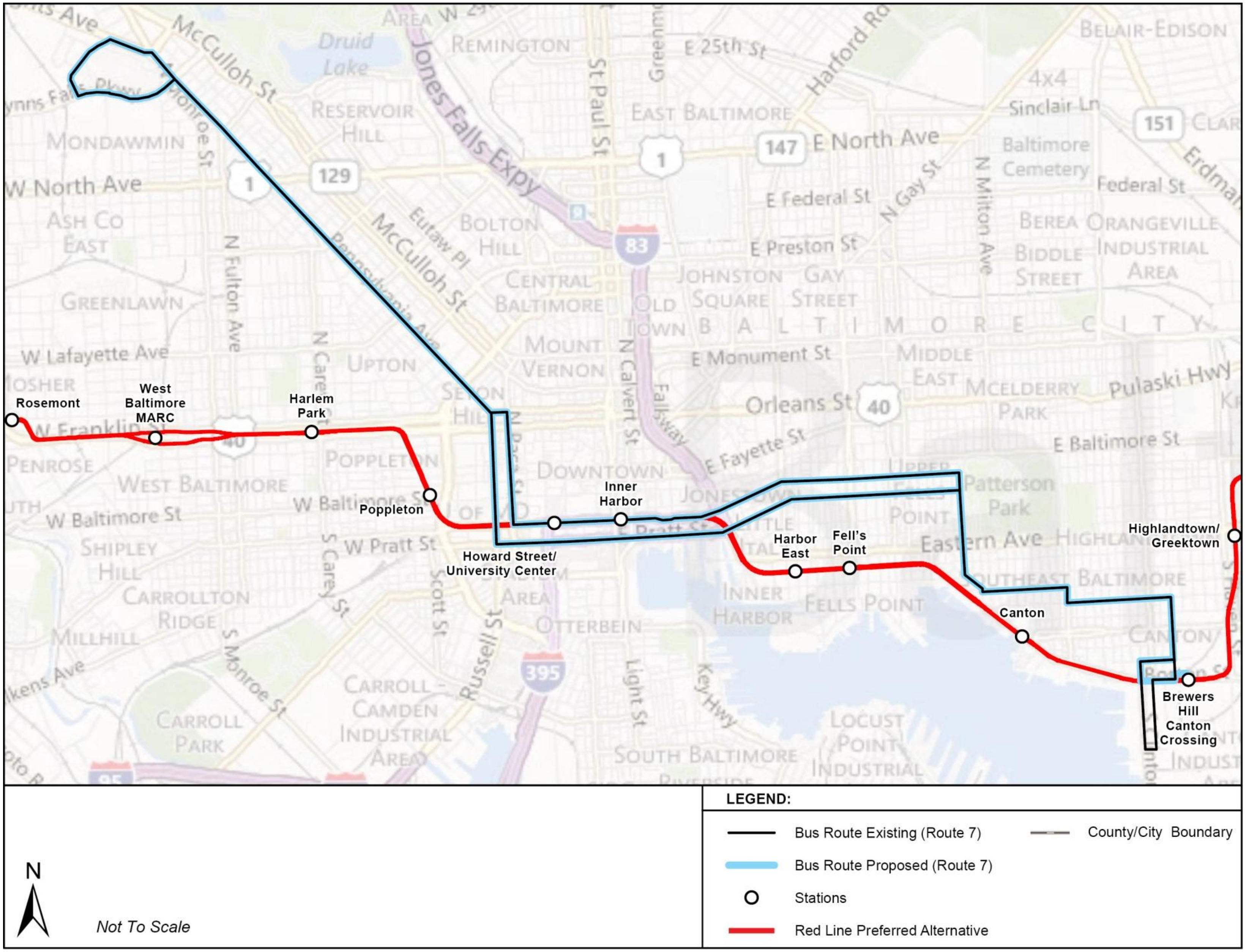
Table 7: Buses Serving Preferred Alternative Stations

Station	Terminating Routes		Pass-through Routes	Required Off-street Infrastructure
	Laying over at station	On-street turnaround		
CMS	None		15W, 20, 20W, 44	
Security Square	15W, 20, 20W, 44, 57		77	Bus turnaround loop and 5 bus bays
SSA	None		77	
I-70 Park-and-Ride	23W, 30, 150		None	Bus turnaround loop and 3 bus bays
Edmondson Village	None		20, 20W, 23, 30, 38	
Allendale	None		23, 38	
Rosemont	None	10W, 15W	16, 23, 38, 47	
West Baltimore MARC	None	20W	23, 47, 51	
Harlem Park	None		1, 23	
Poppleton	None	15E	1, 10, 20, 30	
Howard Street/University Center	None		many MTA routes	
Inner Harbor	None		many MTA routes	
Harbor East	None	11	21	
Fell's Point	None		None	
Canton	None		13	
Brewers Hill/Canton Crossing	7, 13, 20E		None	Bus turnaround loop and 3 bus bays
Highlandtown/Greektown	None	10E	10, 22	
Bayview Campus	None	23E, 40X	20, 22, 23, 30 (peak only), 40L	
Bayview MARC	22		24	Bus turnaround loop and 1 bus bay (constructed by Baltimore City)

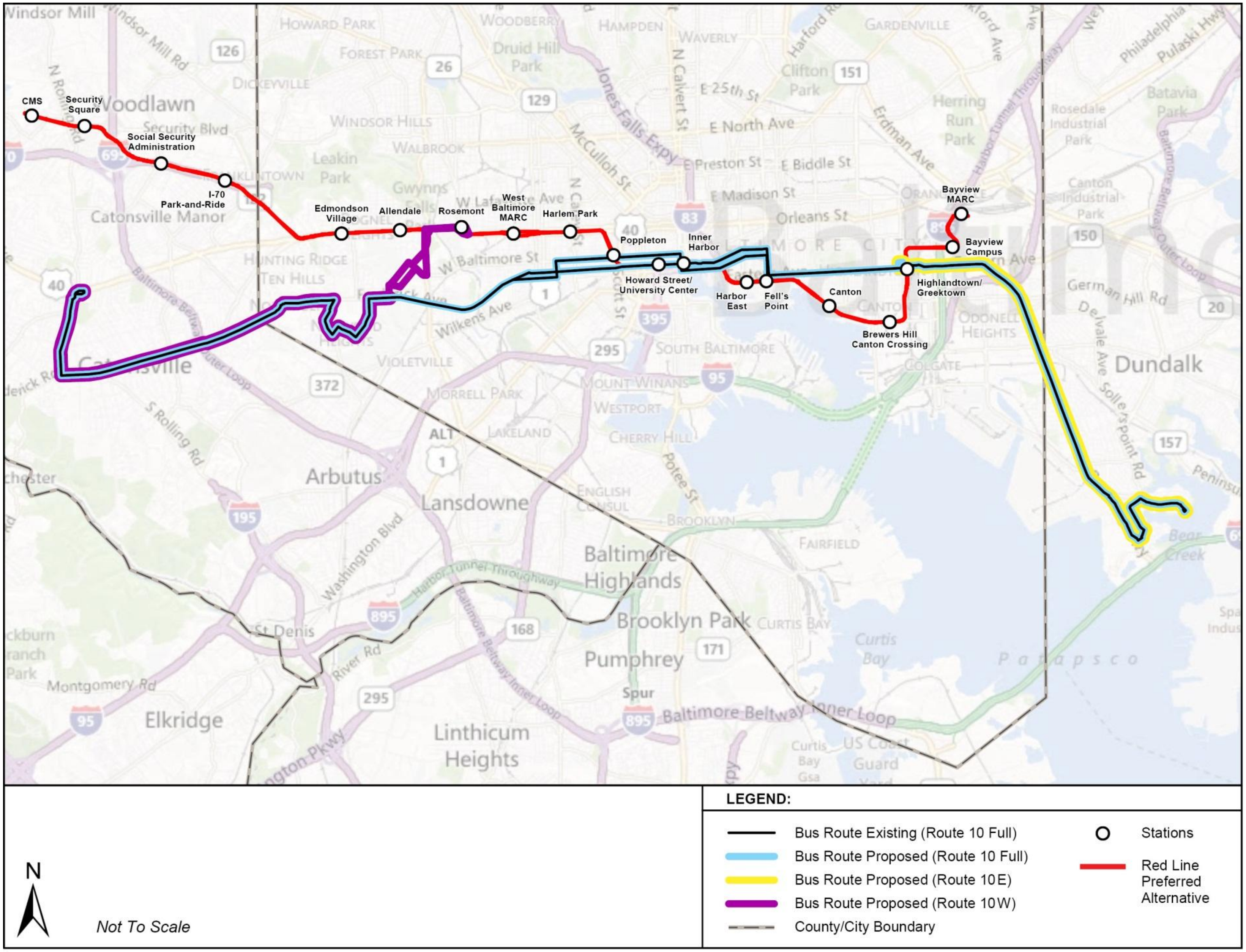
Appendix A
Route Maps



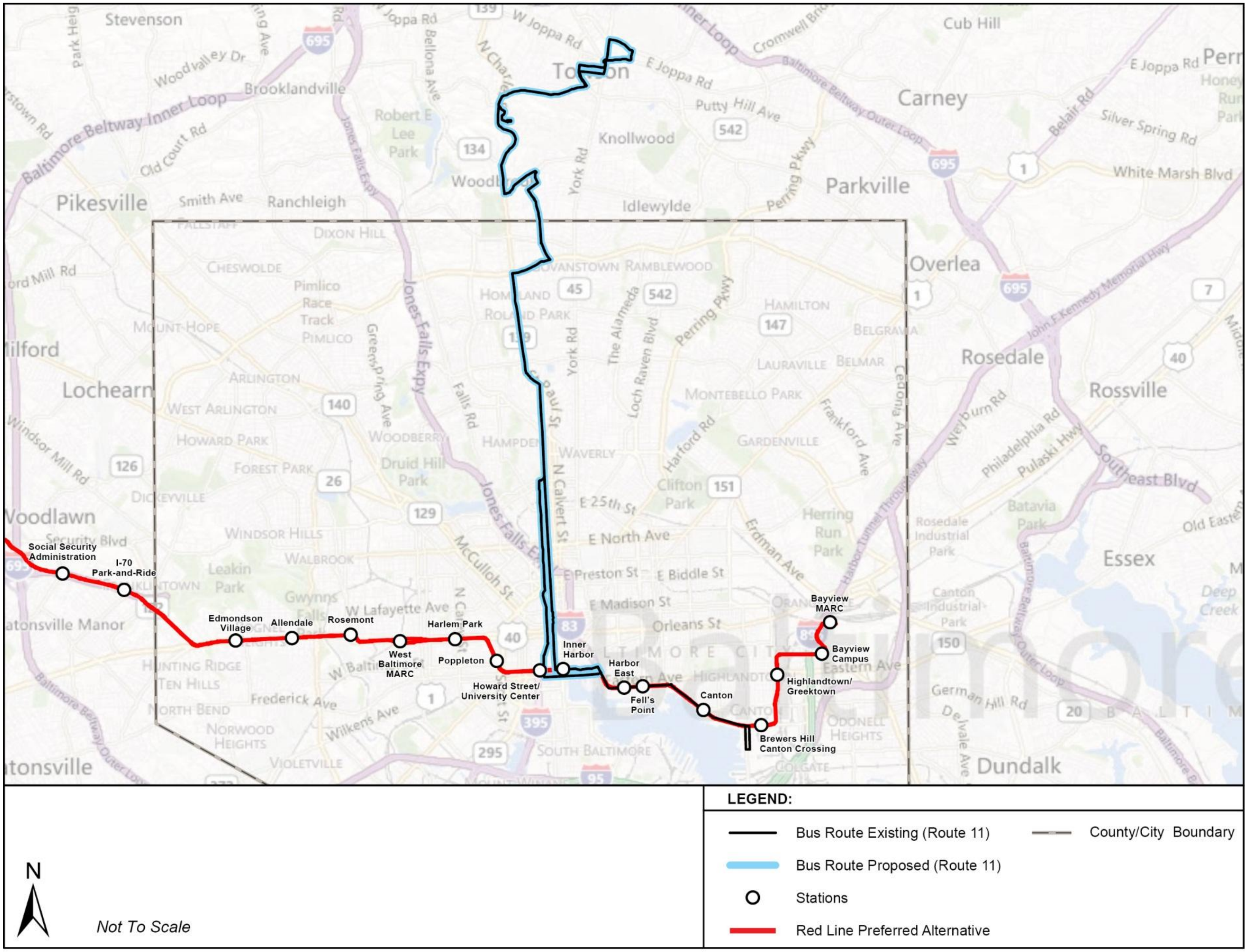
Appendix A: Route 1



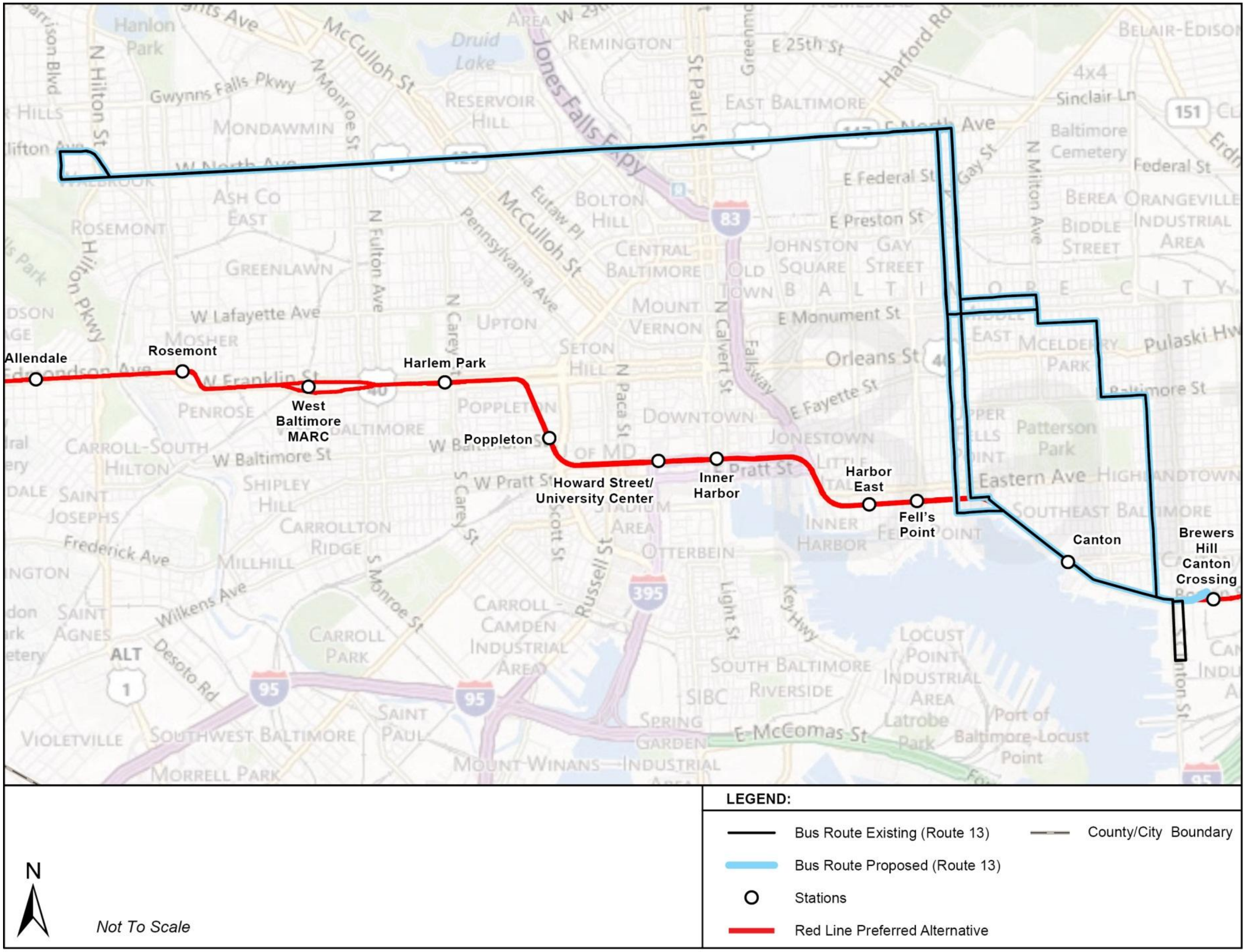
Appendix A: Route 7



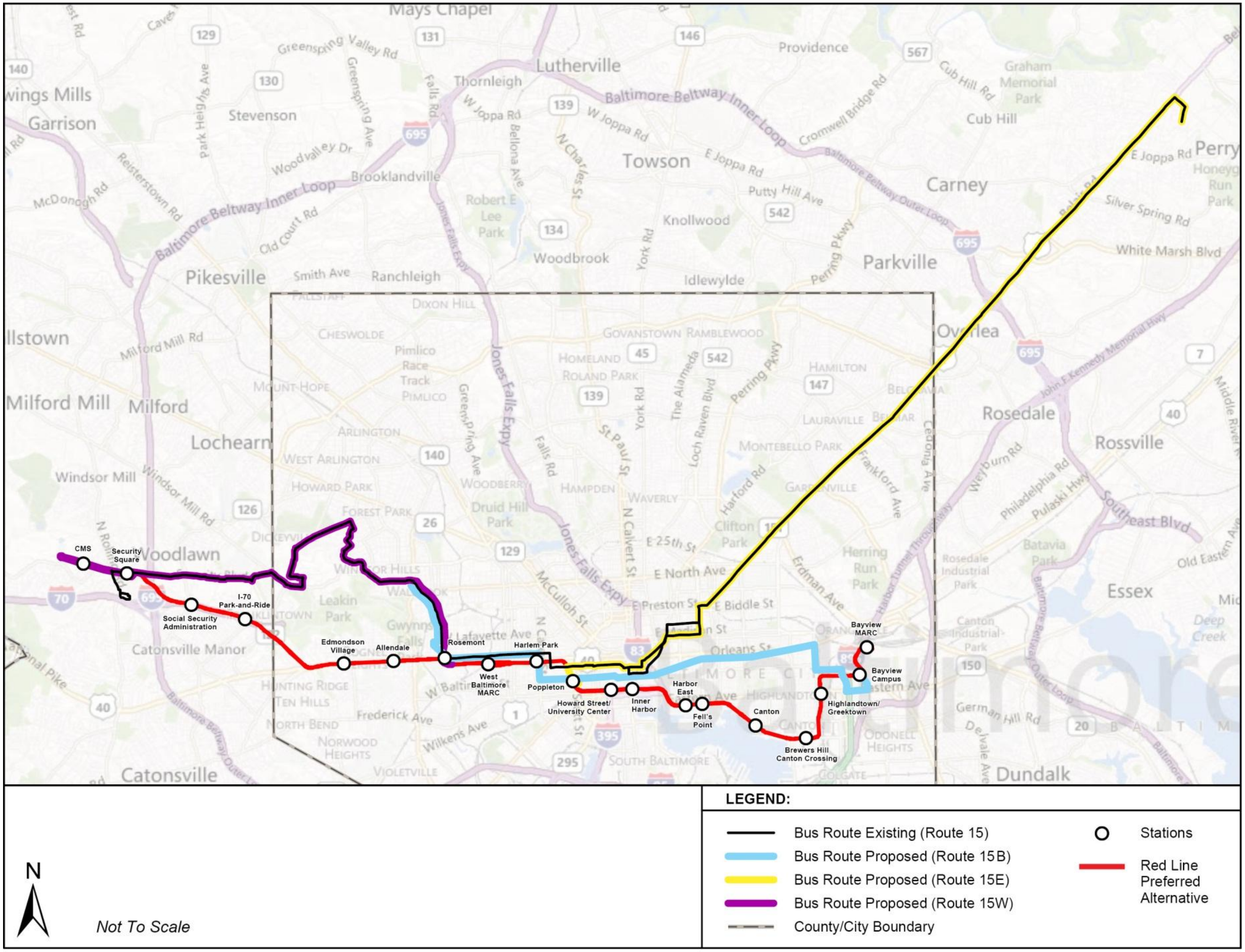
Appendix A: Route 10



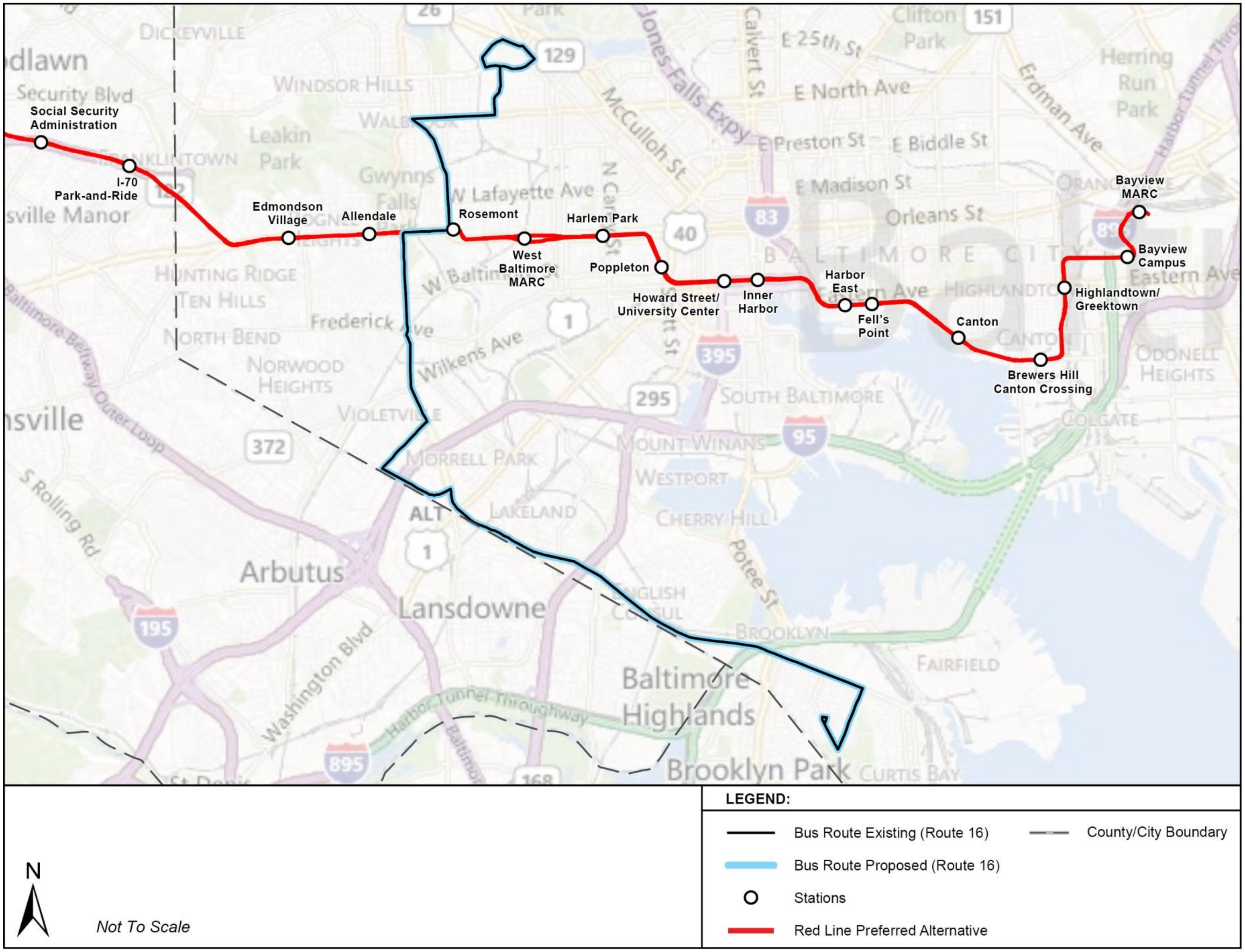
Appendix A: Route 11



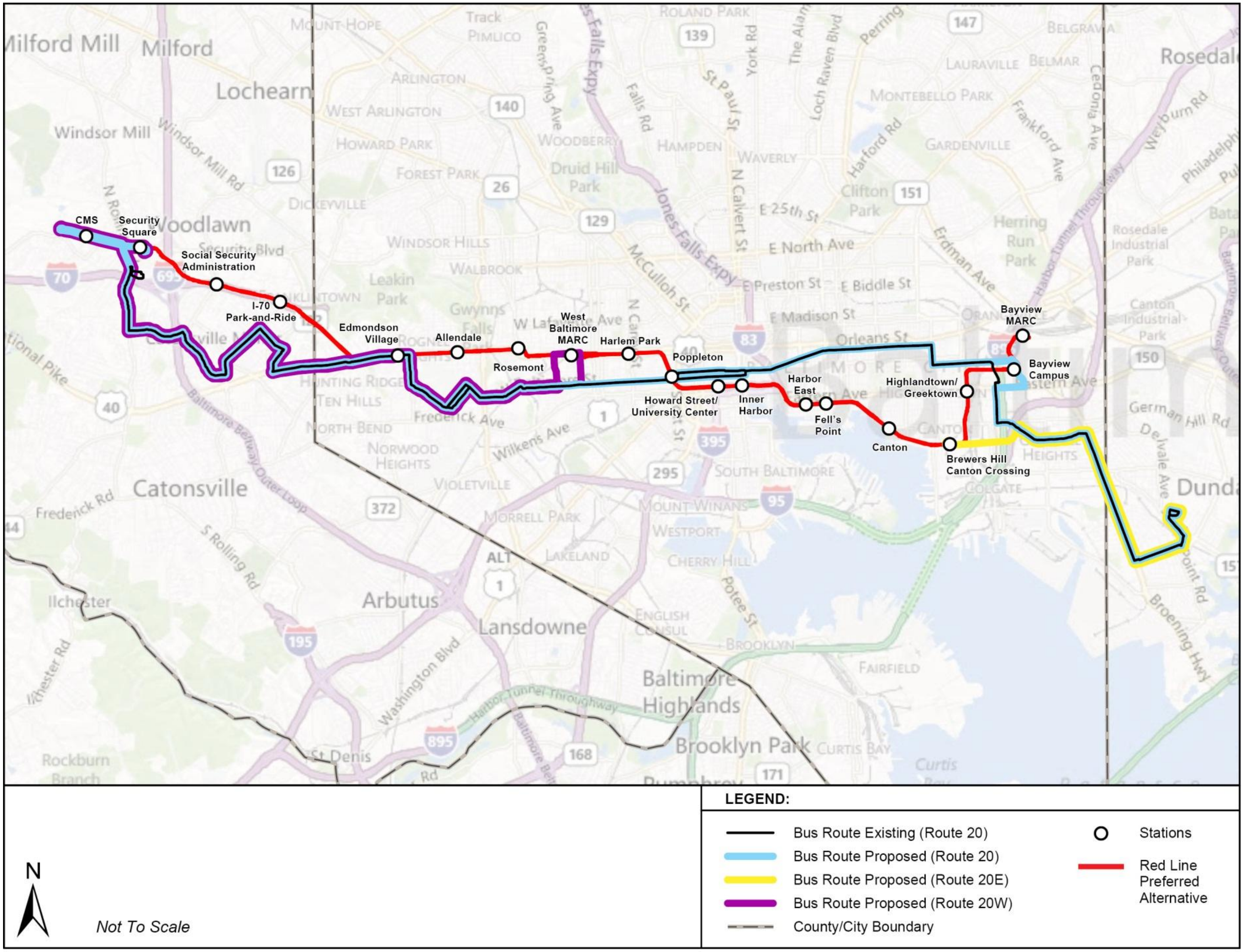
Appendix A: Route 13



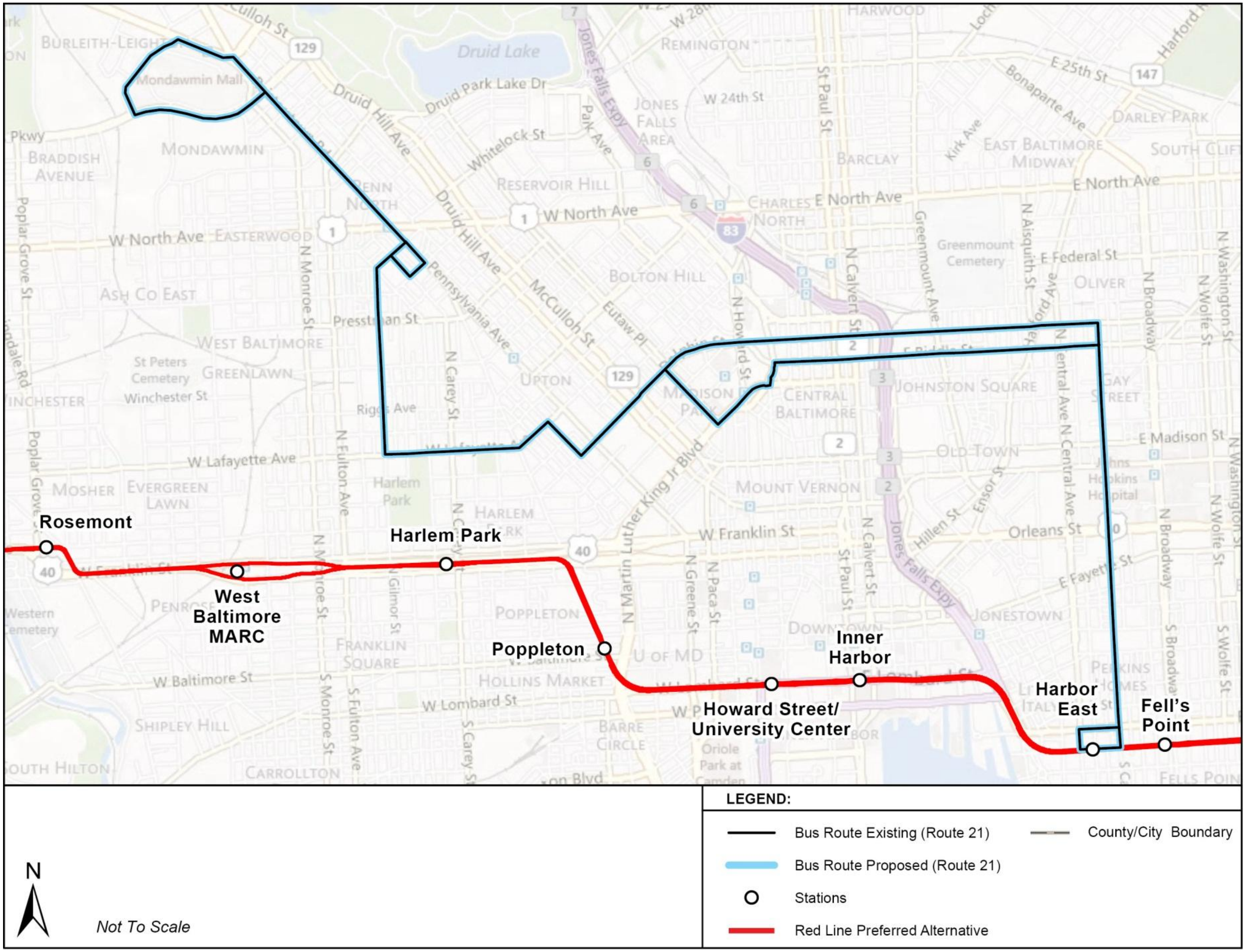
Appendix A: Route 15



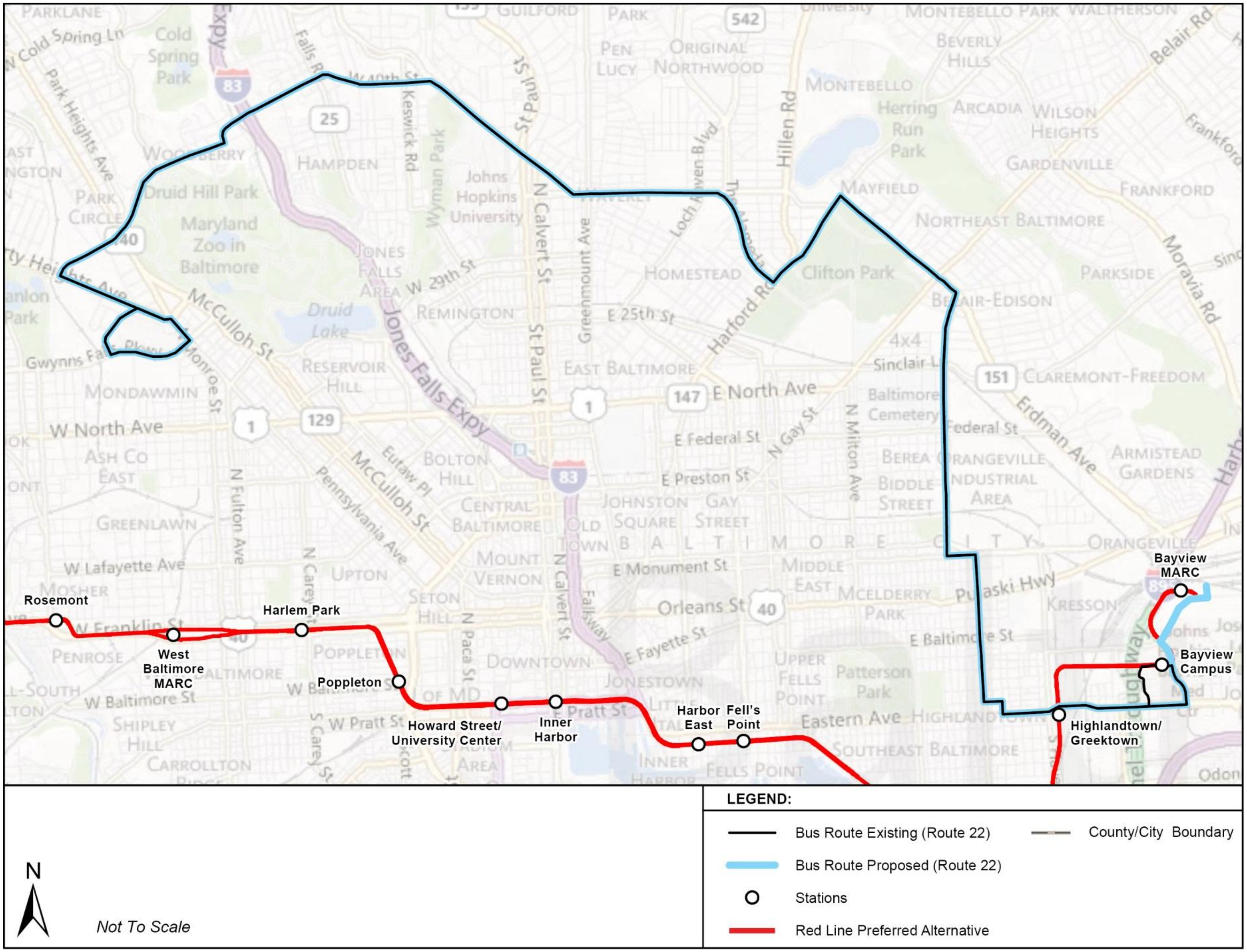
Appendix A: Route 16



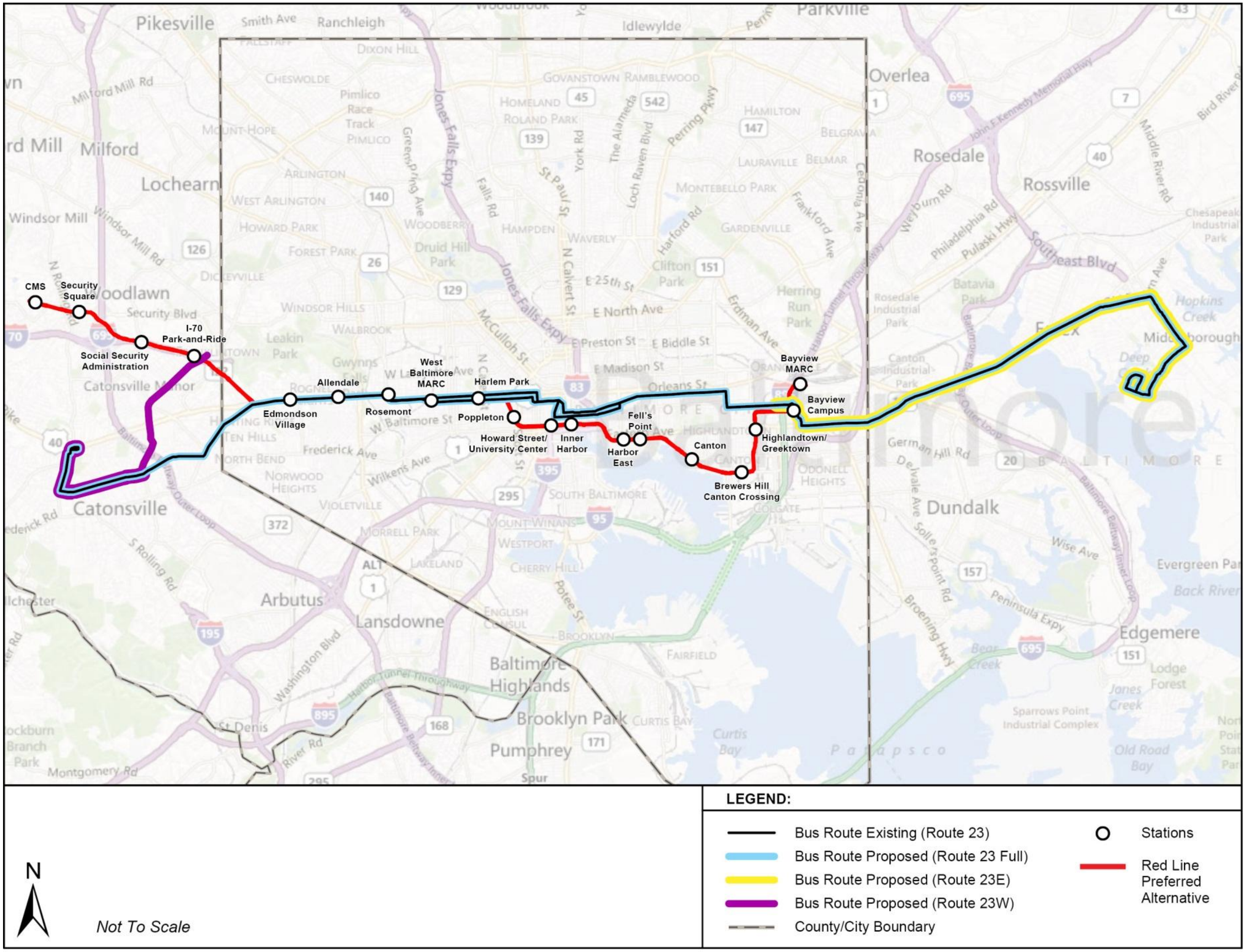
Appendix A: Route 20



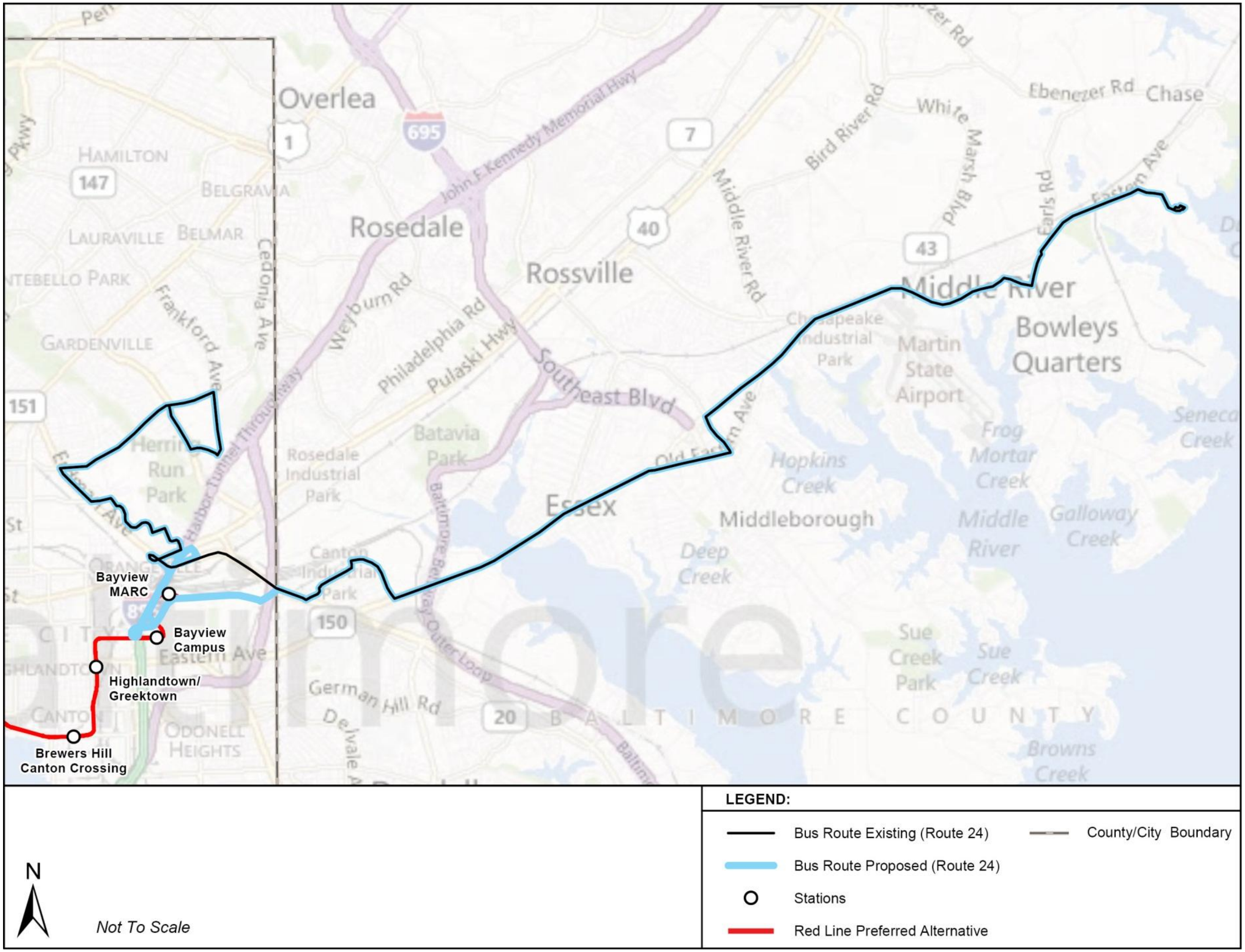
Appendix A: Route 21



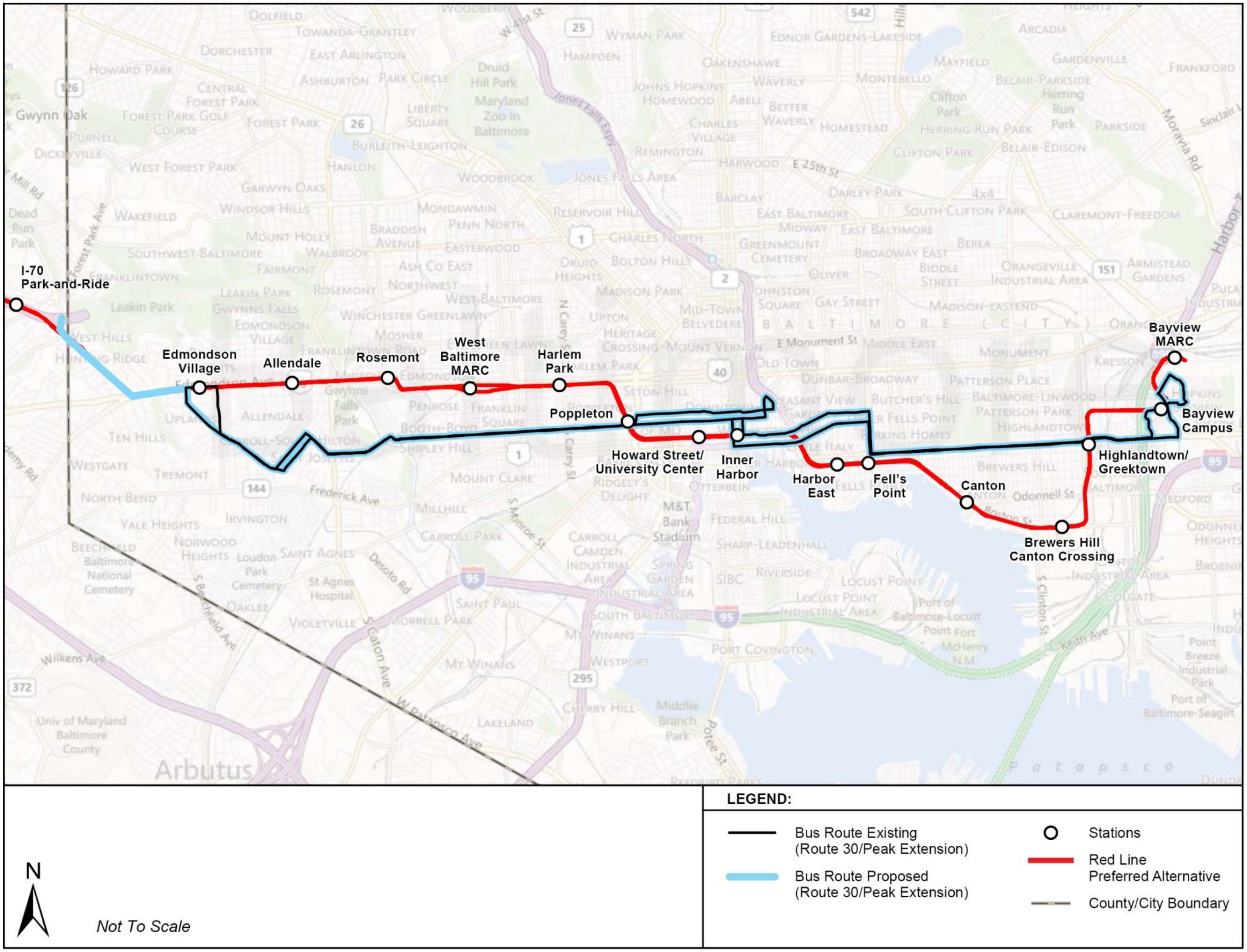
Appendix A: Route 22



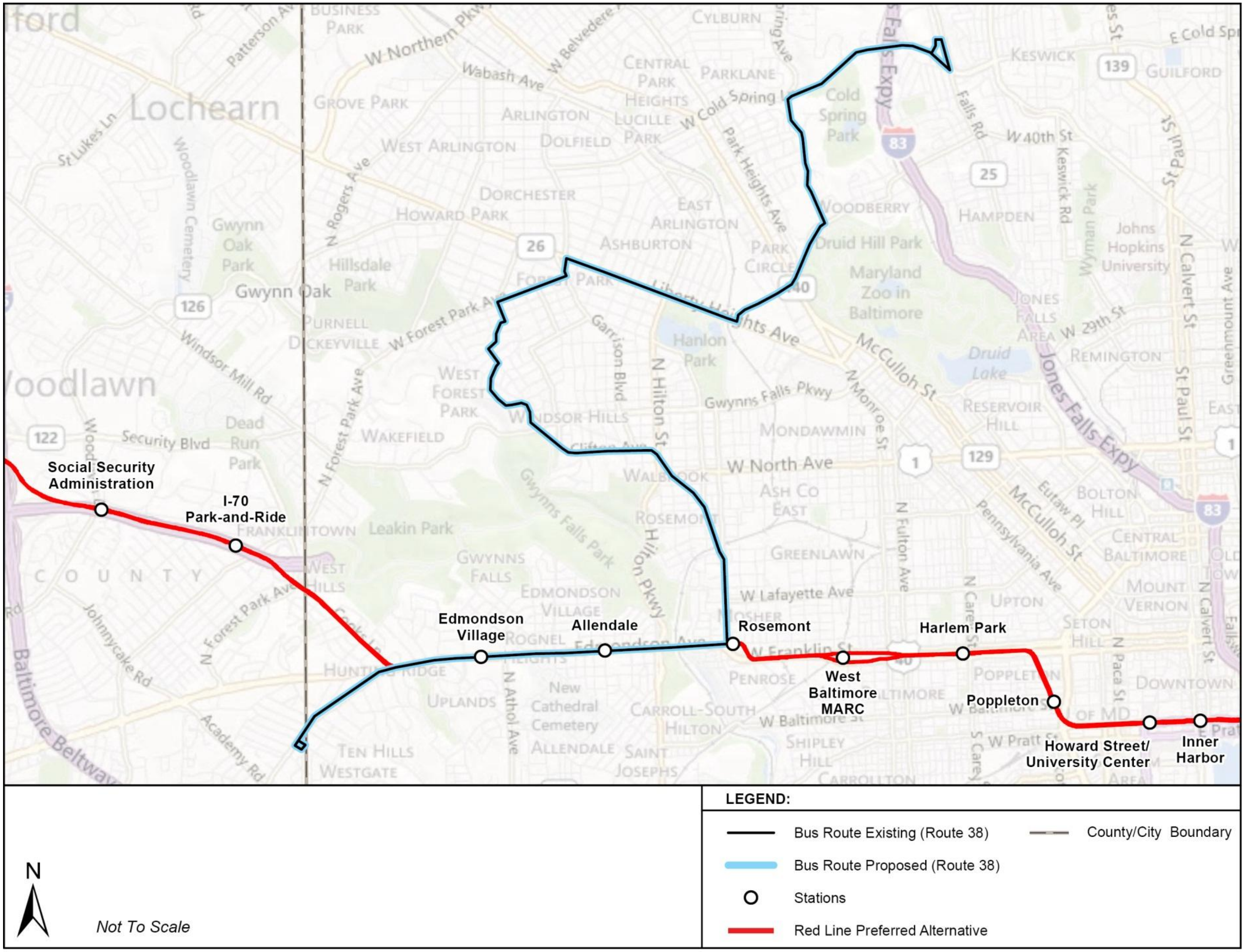
Appendix A: Route 23



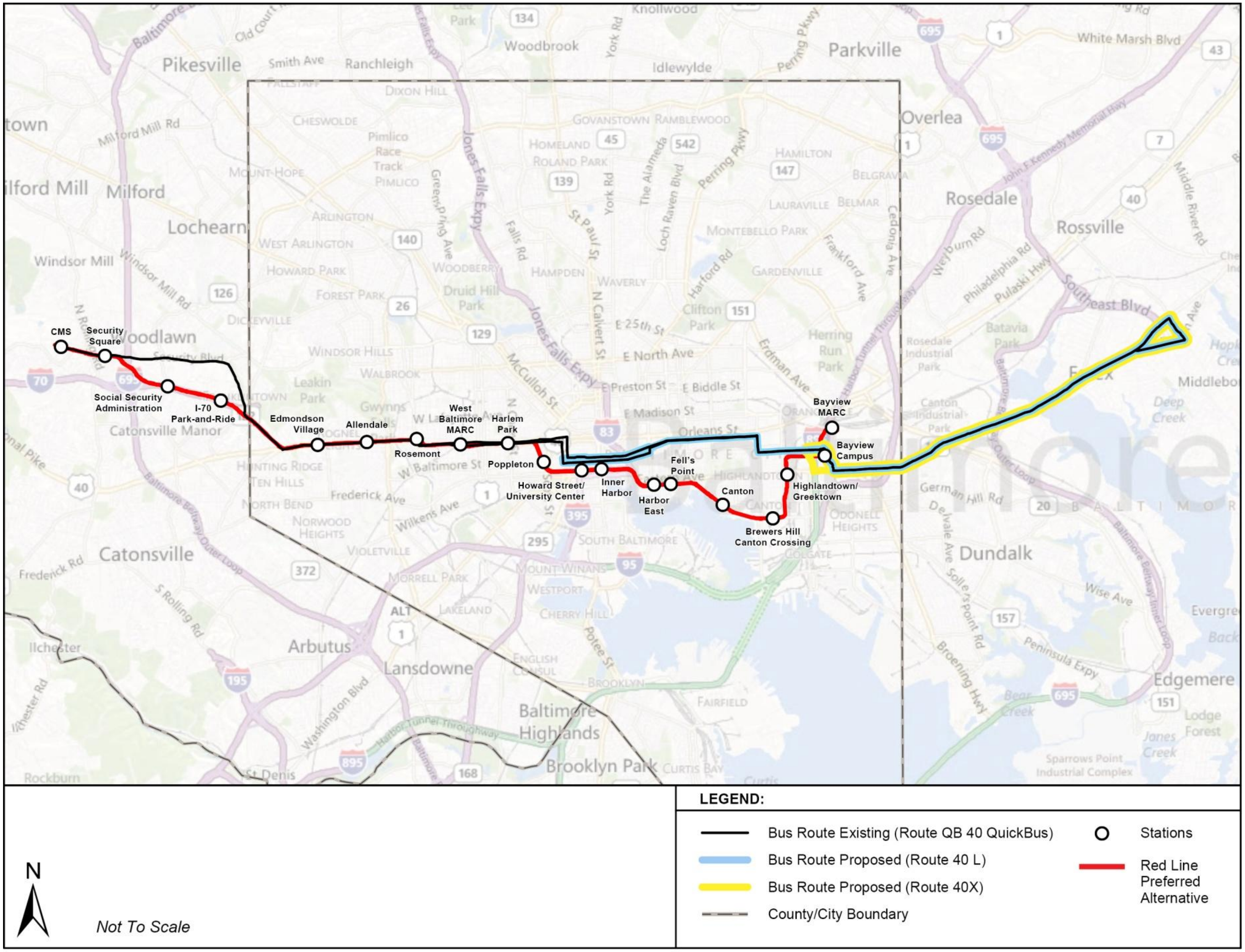
Appendix A: Route 24



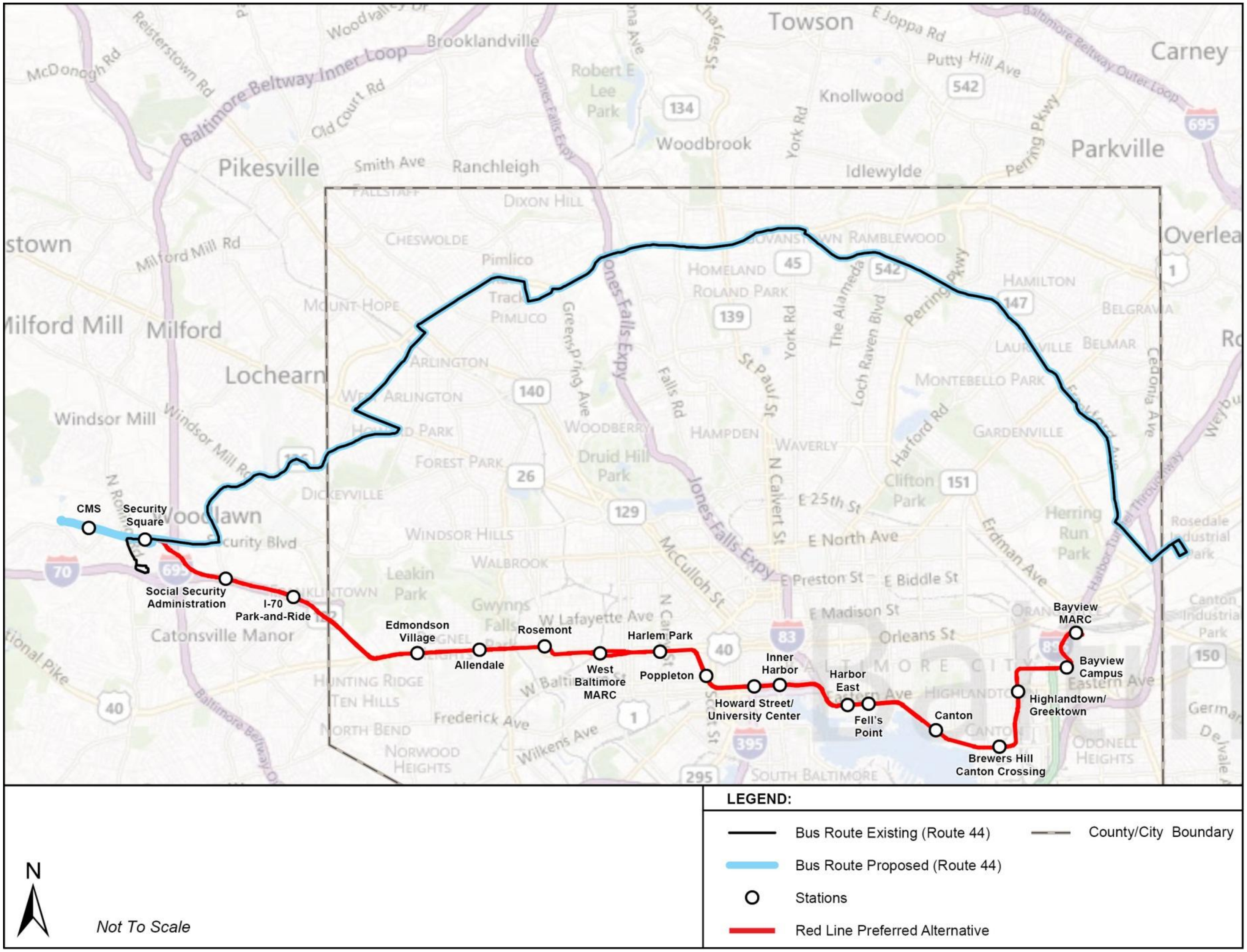
Appendix A: Route 30



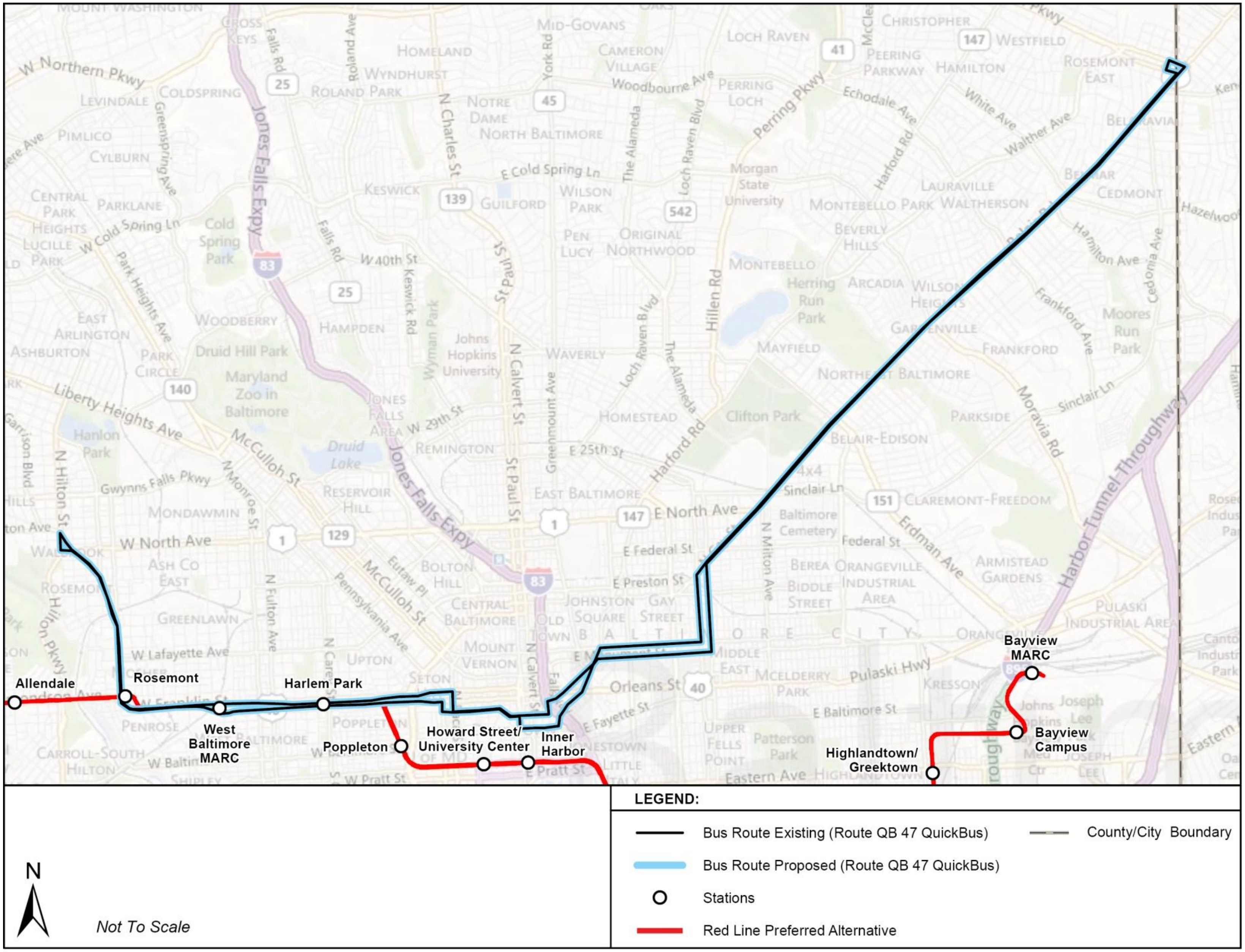
Appendix A: Route 38



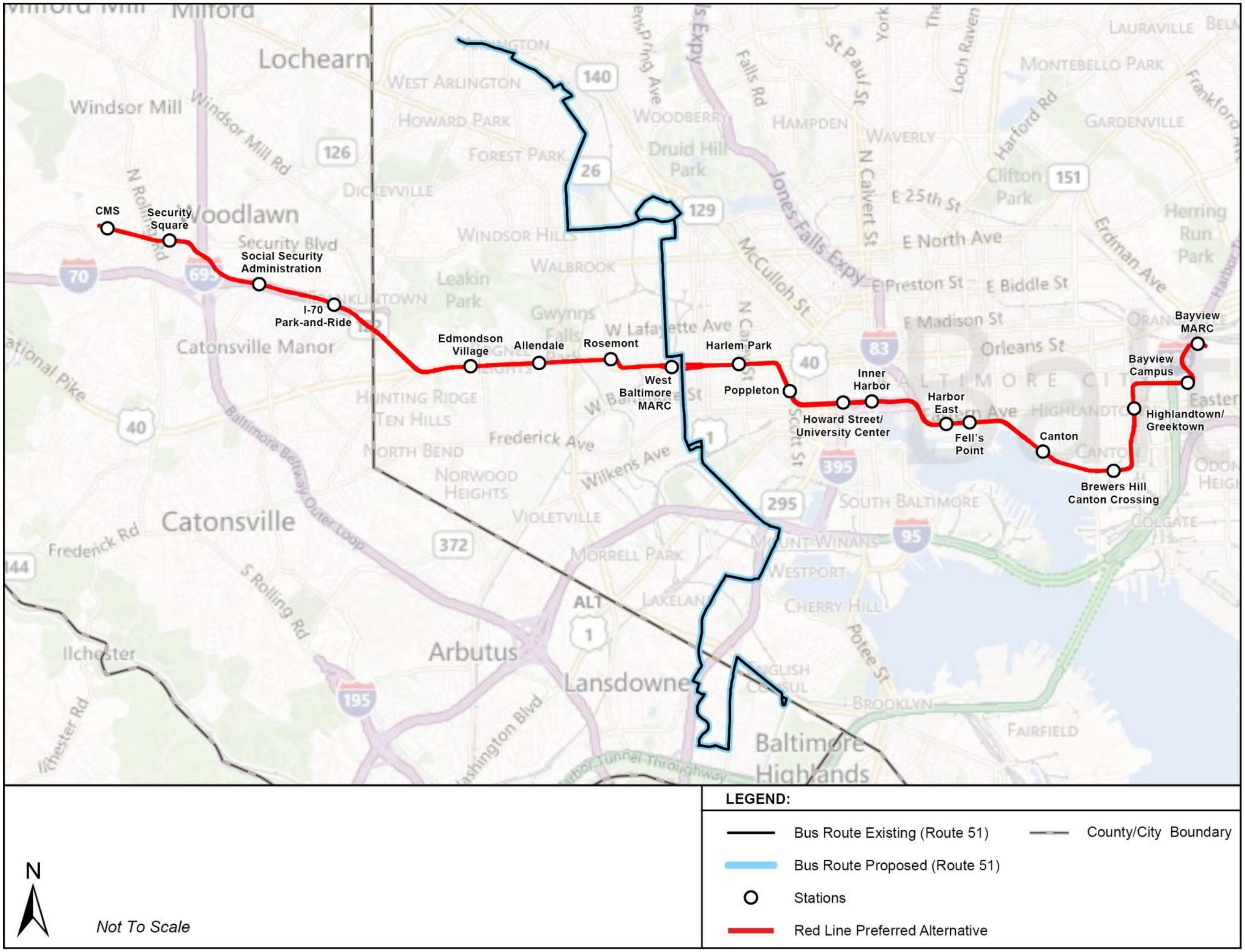
Appendix A: Route 40



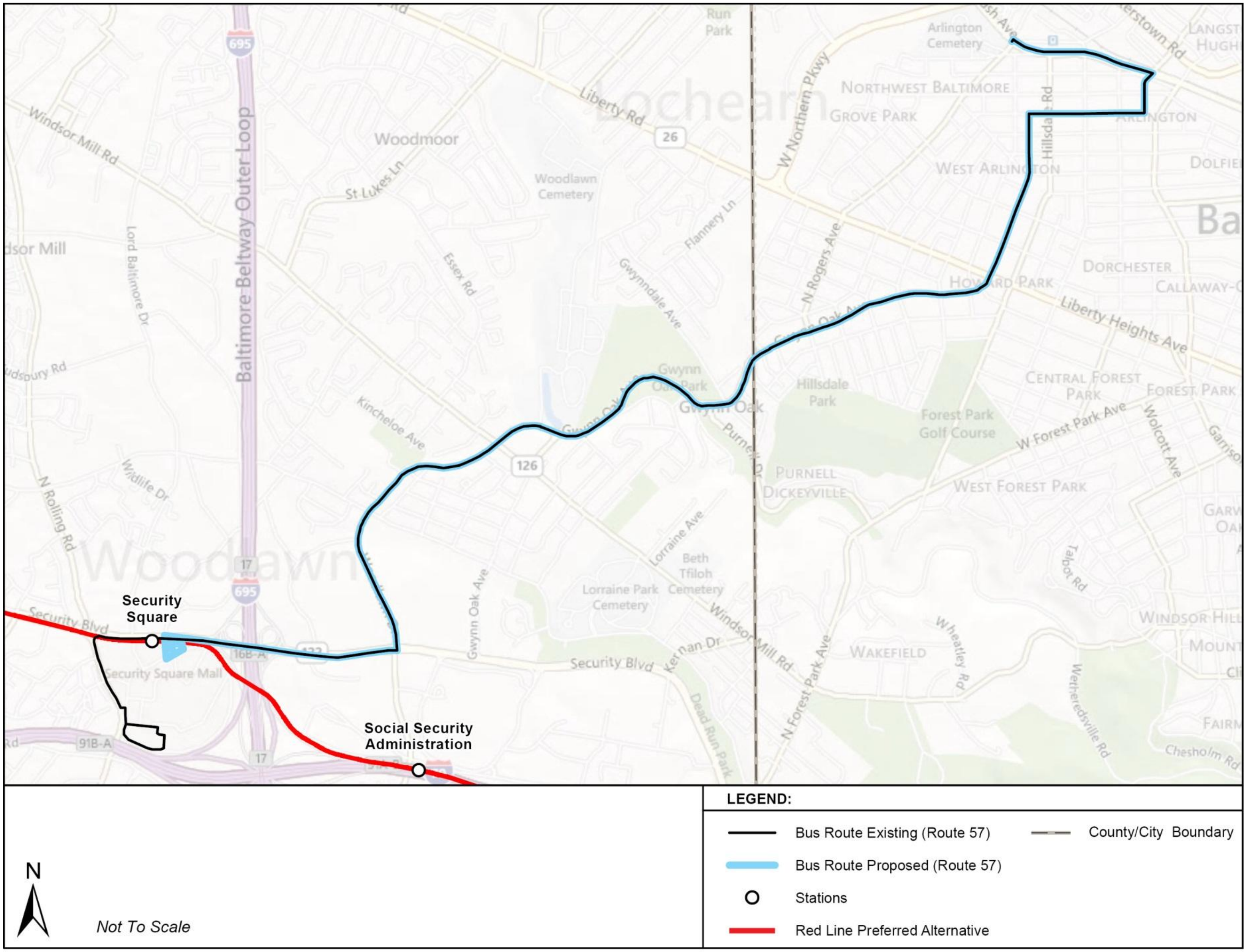
Appendix A: Route 44



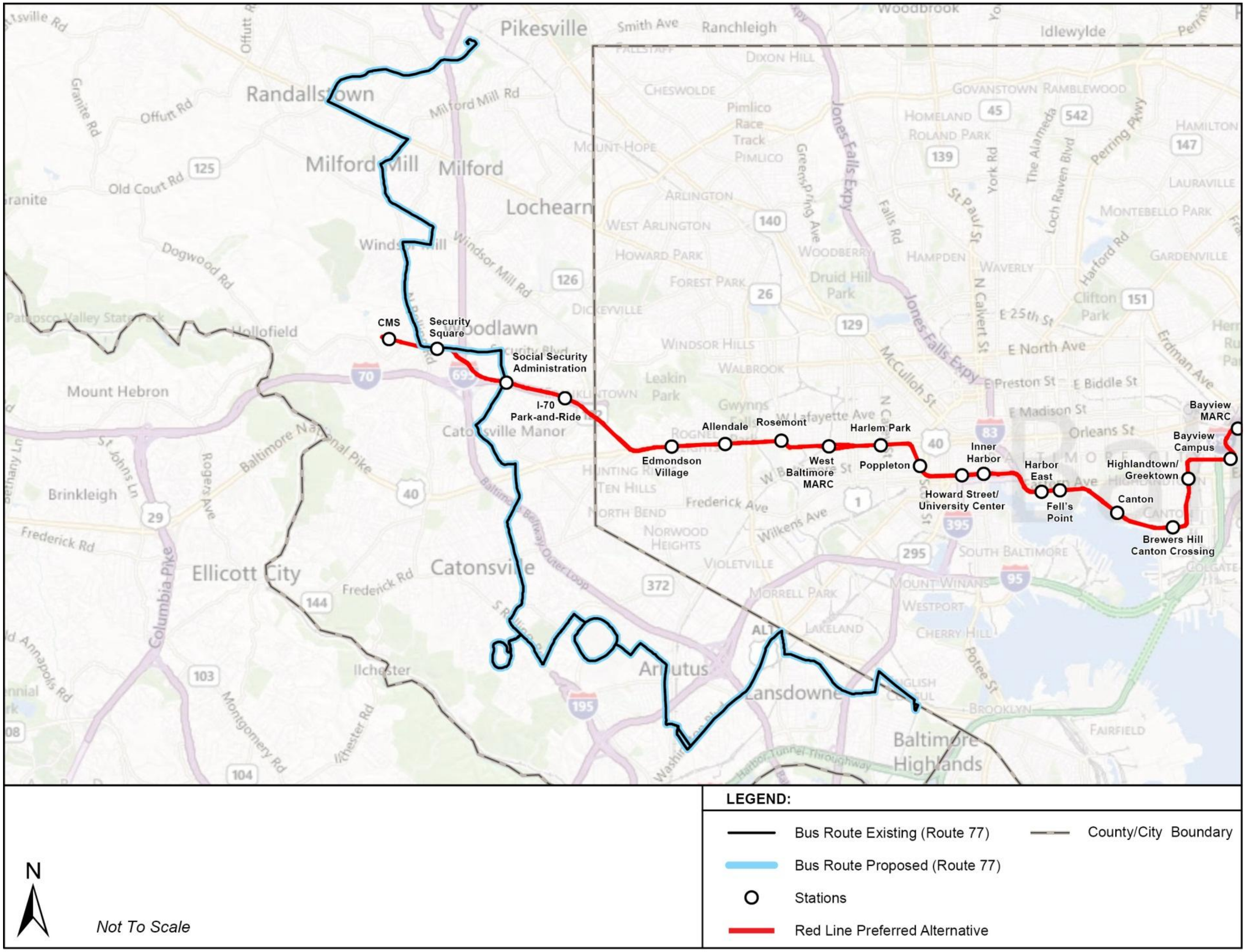
Appendix A: Route QB 47 (QuickBus)



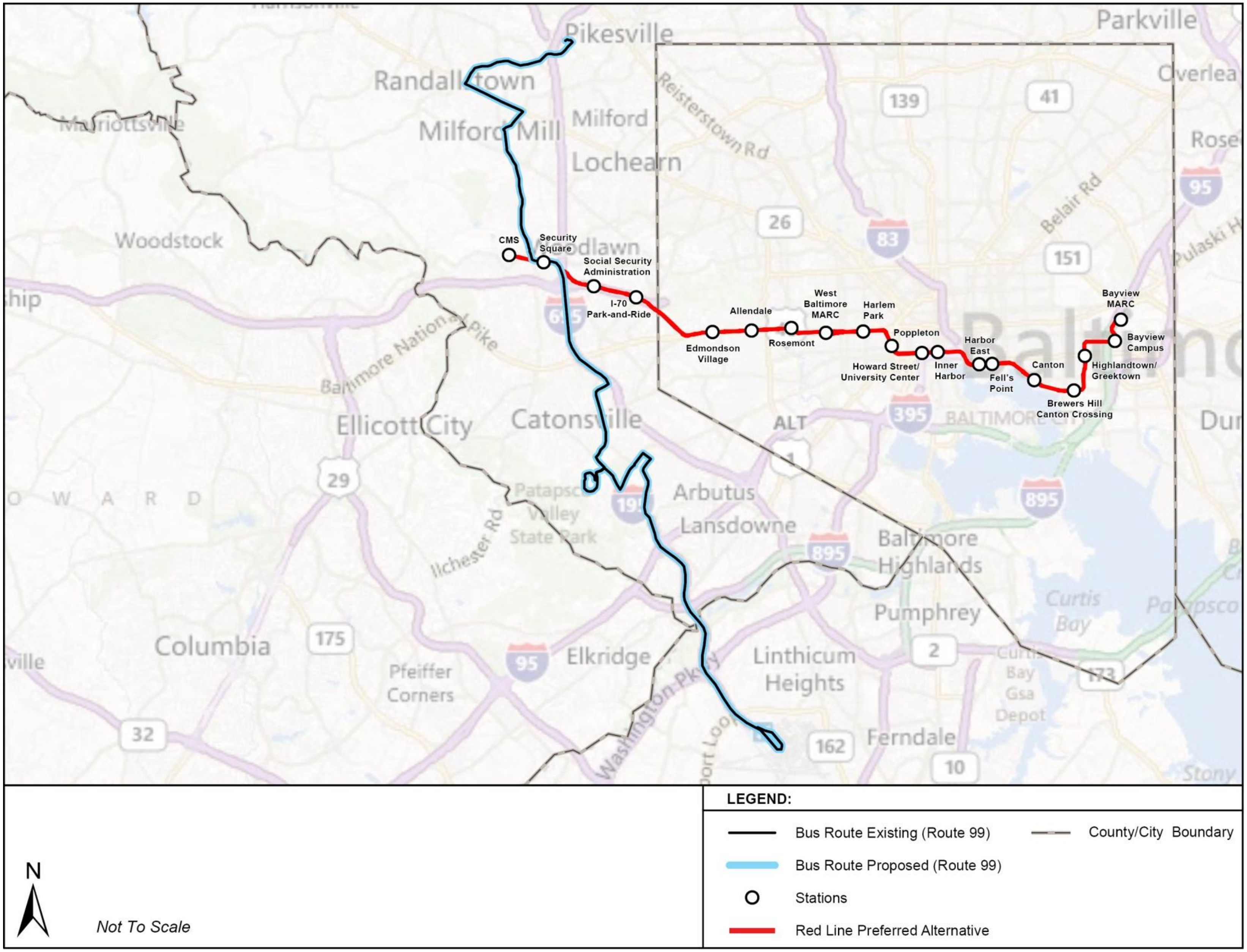
Appendix A: Route 51



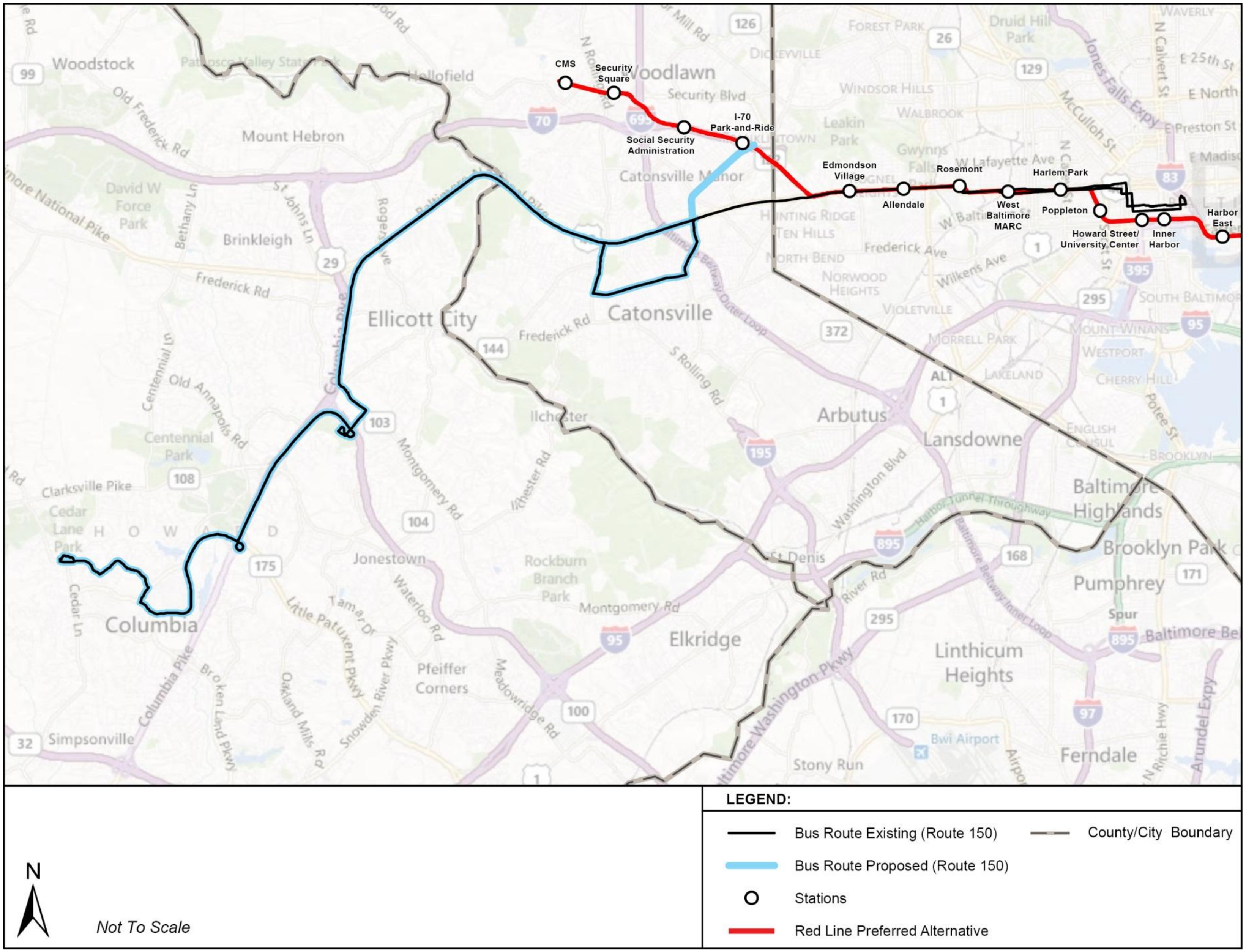
Appendix A: Route 57



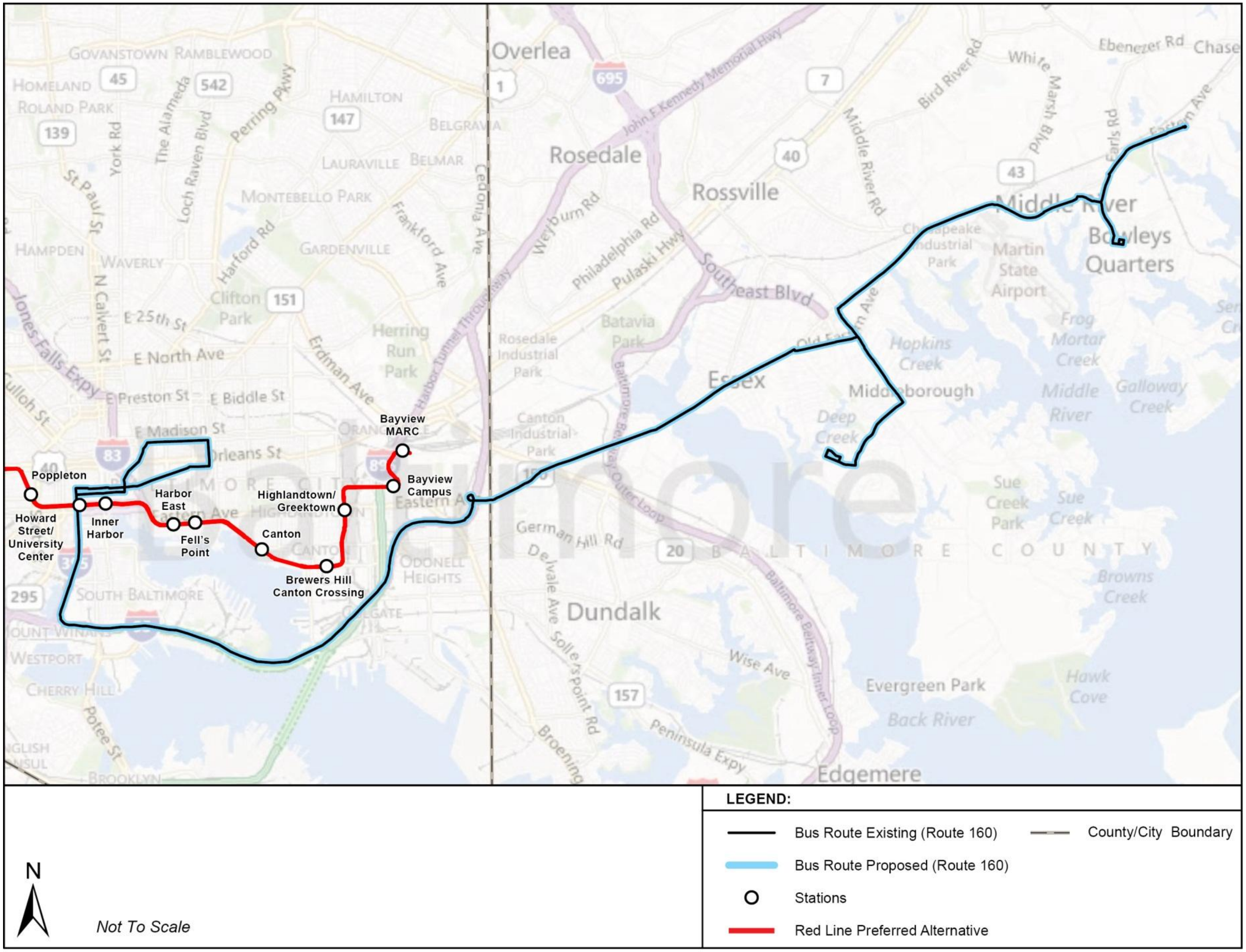
Appendix A: Route 77



Appendix A: Route 99



Appendix A: Route 150



Appendix A: Route 160

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION

MARYLAND TRANSIT ADMINISTRATION

Baltimore, Maryland

Baltimore Red Line

Red Line General Engineering Consultant

Environmental Justice Technical Report December 2012

Document No.
1729

Table of Contents

1. Introduction

The purpose of this technical report is to provide an overview of the socio-economic composition of the residents that live in the neighborhoods within the Red Line project study corridor and to identify the impacts to those areas that meet or exceed the environmental justice (EJ) criteria. This analysis and technical report have been prepared in support of the Red Line Final Environmental Impact Statement (FEIS). These EJ populations have the potential to have positive benefits or to be disproportionately and adversely effected as a result of the Red Line project during and after construction.

1.1 Preferred Alternative

The Red Line Preferred Alternative is a proposed 14.1-mile light rail transit line that would operate from the Centers for Medicare & Medicaid Services (CMS) in Baltimore County to the Johns Hopkins Bayview Medical Center campus in Baltimore City (**Figure 1**). The transitway includes a combination of surface, tunnel, and aerial segments. The alignment, stations, park-and-ride facilities, system elements, tunnel ventilation, light rail vehicles, operations and maintenance facility, and rail and bus operations plans are described in this section.

For analysis purposes, the project study corridor has been divided into five segments consisting of three at-grade/aerial segments and two tunnel segments totaling approximately 14.1 miles. From west to east, these segments are: (1) West, (2) Cooks Lane Tunnel, (3) US 40, (4) Downtown Tunnel, and (5) East.

Segments

a. West Segment (2.9 miles)

The west segment begins in Baltimore County at the CMS Station, a center-platform station, located west of Rolling Road on the south side of Security Boulevard. At the western end of the Preferred Alternative, 380 feet of tail track would be provided beyond the station for the purpose of operation flexibility. The Preferred Alternative would continue east in an exclusive right-of-way adjacent to the south side of Security Boulevard. The Preferred Alternative would continue east with at-grade crossings at Greengage Road, Brookdale Road, Boulevard Place Shopping Center entrance, and Rolling Road. From Rolling Road, the Preferred Alternative would run adjacent and parallel to the south side of Security Boulevard and along the northern boundary of Security Square Mall crossing Lord Baltimore Drive at grade. The Preferred Alternative would continue to the center platform Security Square Station located immediately west of Belmont Avenue. A park-and-ride lot is proposed at this station and at full development would have 325-375 parking spaces.

The Preferred Alternative would extend east across Belmont Avenue at grade to the west side of I-695 (Baltimore Beltway), continuing southeast and crossing the interchange diagonally on an aerial structure over I-695. The Preferred Alternative would continue adjacent to the existing parking lots at the Social Security Administration (SSA) west campus and along the north side of the I-70 ramp to I-695.

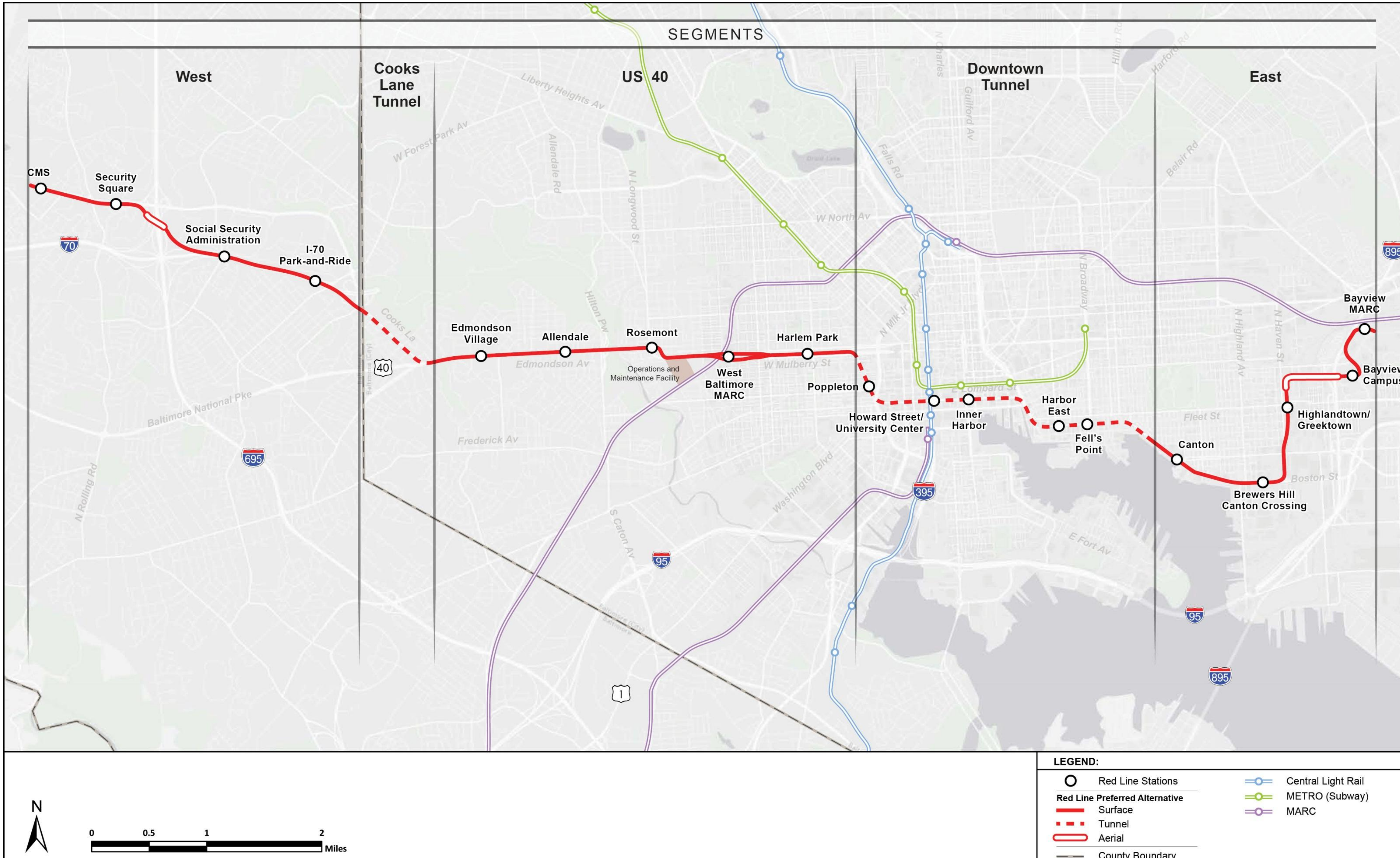


Figure 1: Red Line Preferred Alternative

The Preferred Alternative would continue east transitioning onto the existing excess pavement of westbound I-70, just west of Woodlawn Drive, to the center platform SSA Station just east of Woodlawn Drive.

Continuing east, the Preferred Alternative would cross at grade with a roadway connection from I-70 to Parallel Drive and continues on the former roadway pavement to the I-70 Park-and-Ride Station. The station and park-and-ride facility are located west of Ingleside Avenue occupying the on-ramps to the former westbound I-70. Initially, the I-70 Park-and-Ride lot would have 650-700 parking spaces with the opportunity for expansion in the future.

Continuing east of the I-70 Park-and-Ride Station, the Preferred Alternative would cross over Ingleside Avenue on an existing bridge and curves in a southeast direction to the tunnel portal for the Cooks Lane Tunnel segment.

b. Cooks Lane Tunnel Segment (1.3 miles)

The Preferred Alternative surface alignment would transition to a 734-foot portal section in the southwest quadrant of the existing cloverleaf interchange at the end of I-70. This existing interchange loop ramp would be removed as part of the project. This tunnel section would begin through the portal on the northwest side of the intersection of Cooks Lane/Forest Park Avenue/Security Boulevard. The tunnel alignment would continue southeast under the intersection in a twin-bore tunnel beneath Cooks Lane crossing into Baltimore City. The tunnel would continue southeast centered under Cooks Lane to north of Coleherne Road; then curve left towards Edmondson Avenue and continues east following the centerline of Edmondson Avenue. The tunnel would continue along the centerline of Edmondson Avenue ascending through a portal section to meet grade approximately 400 feet west of Swann Avenue.

c. US 40 Segment (3.3 miles)

The US 40 segment would begin after the tunnel portal, continuing east in an exclusive right-of-way along the median of Edmondson Avenue crossing Swann Avenue at grade to the Edmondson Village Station. This center-platform station is located mid-block between Swann Avenue and North Athol Avenue.

The Preferred Alternative would continue east in the median of US 40 with at-grade crossings at traffic signal-controlled intersections at North Athol Avenue, Wildwood Parkway, and North Louden Avenue to the Allendale Station at the intersection of US 40 and Allendale Street. The Allendale Station would have a split platform with the westbound platform located on the west side of Allendale Street and the eastbound platform located on the east side of the intersection. The Preferred Alternative would continue east at grade across Denison Street and Hilton Street. The Preferred Alternative would cross over the Hilton Parkway and Gwynns Falls in the center of an existing bridge. Baltimore City is currently developing plans to replace the existing Edmondson Avenue Bridge with designs to include accommodations for the Red Line.

The Preferred Alternative would continue east at grade through the Edmondson Avenue (US 40)/Franklin Street intersection and Poplar Grove The Rosemont Station platform would be located in the center of Edmondson Avenue east of Poplar Grove Street. East of the Rosemont Station, the Preferred Alternative would turn right and traverse south along the center of

Franklintown Road. At the intersection of Franklintown Road and Franklin Street, the Preferred Alternative would turn left and continue east along the median of US 40/Franklin Street. This is also the proposed location for the Operations and Maintenance Facility (OMF) site on the south side of Franklin Street. Following the existing roadway, the Preferred Alternative would split near Wheeler Avenue and continue east diverging to cross under the Amtrak Northeast Corridor. The Preferred Alternative would maintain the existing structures over West Franklin Street and West Mulberry Street with minor modifications to the bridge structures, roadway, and utilities to protect the structures. The eastbound track would be adjacent to the north side of Mulberry Street, crossing under the existing Amtrak bridge to the West Baltimore MARC Station eastbound platform located at the northwest corner of Smallwood Street and Mulberry Street. The West Baltimore MARC Station westbound platform is located at the southwest corner of Smallwood Street and Franklin Street. The westbound track is adjacent to the south side of Franklin Street. The split tracks would continue east along the edge of the West Baltimore MARC parking lots with separate at-grade crossings of Pulaski Street and Payson Street. The tracks diverge from Franklin and Mulberry Streets and rejoin just west of the North Fulton Avenue Bridge.

The Preferred Alternative would continue east in the median of the existing US 40 lower level roadway corridor. The Preferred Alternative tracks would split east of the Stricker Street pedestrian bridge onto the eastbound left lane of the US 40 corridor. The Harlem Park Station, a center platform station, would be located between Calhoun Street and Carey Street. East of Carey Street the tracks would merge back to double-track before passing under the existing pedestrian bridge at Carrollton Avenue. The Preferred Alternative would continue under the Arlington Avenue Bridge to the portal for the Downtown Tunnel.

d. Downtown Tunnel Segment (3.4 miles)

The tunnel would begin in the median of US 40 immediately west of the North Schroeder Street Bridge and would continue east descending into a 1,200-foot tunnel portal within the median of US 40. The tunnel would then curve underneath Mulberry Street and continue south, beneath Fremont Avenue to the proposed underground Poppleton Station located immediately north of Baltimore Street. The entrance to the underground Poppleton Station would be located at the northeast corner of the intersection of Fremont Avenue and Baltimore Street.

The tunnel alignment would continue south and curves east crossing underneath Martin Luther King, Jr. Boulevard to the center of Lombard Street. The tunnel would continue east beneath Lombard Street to the underground Howard Street/University Center Station, located immediately east of Howard Street. The entrance to the underground station would be located at the northeast corner of Howard and Lombard Streets. The Preferred Alternative would cross under the existing CSX railroad tunnel beneath Howard Street just west of the proposed station.

The tunnel alignment would continue east to the underground Inner Harbor Station located underneath Lombard Street between Light and Calvert Streets. The entrance to the station would be located at the northeast corner of Lombard and Light Streets and along the north side of Lombard Street west of Calvert Street. From this station there would also be a pedestrian tunnel underneath Light Street to provide a direct connection to the Charles Street Metro Station located underneath Baltimore Street.

The Downtown Tunnel alignment would continue underneath Lombard Street until Market Place where the alignment curves south centered underneath President Street to Fleet Street. The tunnel alignment would then turn east, underneath Fleet Street to the underground Harbor East Station located east of Central Avenue.

The alignment would continue east centered underneath Fleet Street to the underground Fell's Point Station on the west side of Broadway. The entrance to the station would be located in the median of Broadway north of Fleet Street.

The tunnel alignment would continue east underneath Fleet Street to Washington Street and would turn southeast under Chester Street to Boston Street. The tunnel would continue southeast underneath Boston Street to a tunnel portal east of the intersection with Montford Avenue/Hudson Street ascending to the median of Boston Street at surface).

e. East Segment (3.2 miles)

The Preferred Alternative would continue southeast at grade in the median of Boston Street to the Canton Station. The Canton Station would be a center platform station located west of the signalized intersection at South Lakewood Avenue.

Boston Street would be developed as one lane in each direction from Montford Avenue to Conkling Street. The Preferred Alternative would continue along the center of Boston Street with at-grade crossings at the signalized intersections of South Lakewood Avenue, South Kenwood Street, Potomac Street (pedestrians only), South East Street, South Clinton Street, and South Conkling Street to the Brewers Hill/Canton Crossing Station. This center platform station would be located between South Conkling and South Eaton Streets and includes a park-and-ride lot with approximately 500-600 parking spaces.

The Preferred Alternative would continue east, at grade across Eaton Street and would transition diagonally on new right-of-way turning north on the west side of Haven Street. The Preferred Alternative would continue north adjacent to the west side of Haven Street crossing under the O'Donnell Street Bridge into the Canton Railroad right-of-way. The Preferred Alternative would then turn northeast crossing South Haven Street at grade into the Norfolk Southern (NS) right-of-way. The Preferred Alternative would continue north within the NS right-of-way to the Greektown/Highlandtown Station, a side platform station, which would be located south of Old Eastern Avenue. The Preferred Alternative would occupy the western portion of the Norfolk Southern (NS) right-of-way, a currently inactive railroad right-of-way, referred to as Bear Creek Branch.

The Preferred Alternative would continue north over Eastern Avenue on the existing freight railroad bridge and then ascend and turn east onto a new aerial structure, passing overhead of the NS right-of-way. The structure would cross above Janney Street, Kresson Street, CSX railroad, NS railroad, Oldham Street, Ponca Street, and I-895 to the Johns Hopkins Bayview Medical Center campus property. The alignment would continue east at grade along the alignment of Alpha Commons Drive to the Bayview Campus Station. This center platform station would be located immediately west of Bayview Boulevard. The Preferred Alternative would turn north at grade on the east side of Bayview Boulevard continuing north adjacent to Bayview Boulevard with at-grade crossings of Nathan Shock Drive, a National Institutes of Health (NIH) driveway, and Lombard Street. The Preferred Alternative would continue north turning northeast along the eastside of I-895 to the proposed Bayview MARC Station, the eastern terminus of the Preferred Alternative. A park-and-ride lot with approximately 650 parking spaces is proposed as part of a new Bayview MARC Station, as this is a separate project to be implemented by the Maryland Transit Administration (MTA) and Baltimore City. At the eastern end of the alignment, 380 feet of tail track would be provided beyond the station for the purpose of operational flexibility.

Stations

The Preferred Alternative would include 19 stations, 14 surface and 5 underground, to provide access and connections to the light rail service. The proposed Red Line station locations have been identified based upon compatibility with surrounding site conditions, intended passenger catchment areas, site circulation, site services and amenities, transit oriented development opportunities, public space availability, future urban plan visioning, community input through the Station Area Advisory Committees (SAACs), and other public outreach (refer to Chapter 8 of the FEIS for additional information concerning Public Involvement).

Operations and Maintenance Facility

The OMF is where light rail cars would be stored, maintained, and dispatched on their daily routes each day. The OMF would accommodate administrative and light rail operation functions for the Red Line. The site, as currently proposed, would be comprised of 11 existing parcels totaling 20.8 acres in Baltimore City. The OMF would be located along the south side of US 40/Franklin Street centered around Calverton Road between Franklintown Road and Warwick Avenue, and referred to as the Calverton Road site. Currently, these parcels support light industrial uses and would be compatible with the use as the OMF.

At the Calverton Road site, the Red Line OMF would be comprised of three main buildings, light rail track into and out of the facility site, three central instrument houses (CIHs), and two traction power substations (TPSSs) for the mainline and the site, and a covered fuel station. There would be an area for employee and visitor parking totaling approximately 200 spaces, and the site would be secured and fenced.

The overall storage and maintenance facility site as currently programmed would include approximately 77,000 square feet of parking, 12,000 square feet of exterior support spaces, 62,700 square feet of light rail vehicle storage, and 251,000 square feet of lead tracks.

Traction Power Substations and Central Instrument Houses

To provide electricity along the line for the light rail vehicles, 17 TPSSs are proposed and would be located along the alignment. The TPSS require approximately 45-foot by 85-foot sites plus access roads or driveways. A typical TPSS would be constructed of steel housing and depending on the location, could be surrounded by fencing, a brick wall, landscaping, or other forms of aesthetic barriers. The TPSS would be spaced along the alignment, approximately one mile apart. Two TPSS locations would be within underground stations and two locations would be within the proposed OMF. Preliminary locations for TPSS sites have been identified for analysis in the FEIS document and supporting technical reports. These locations are shown on **Figure 2.** Final substation locations would be determined during Final Design for the project.

The signal CIH contains elements of the signaling control system, circuits and equipment required for safe vehicle operation. Currently, eight CIHs are planned along the alignment. The distances between the signal houses vary and are based on the locations of the crossover tracks where light rail vehicles can switch tracks. Another factor that determines the location of the CIHs is the ability to have an unobstructed view between them. The CIH structures are prefabricated steel structures approximately 10 feet by 40 feet and 10-feet high. Preliminary locations for the CIH have been identified for analysis in the FEIS document and supporting technical reports. The CIH locations are shown on **Figure 2.**

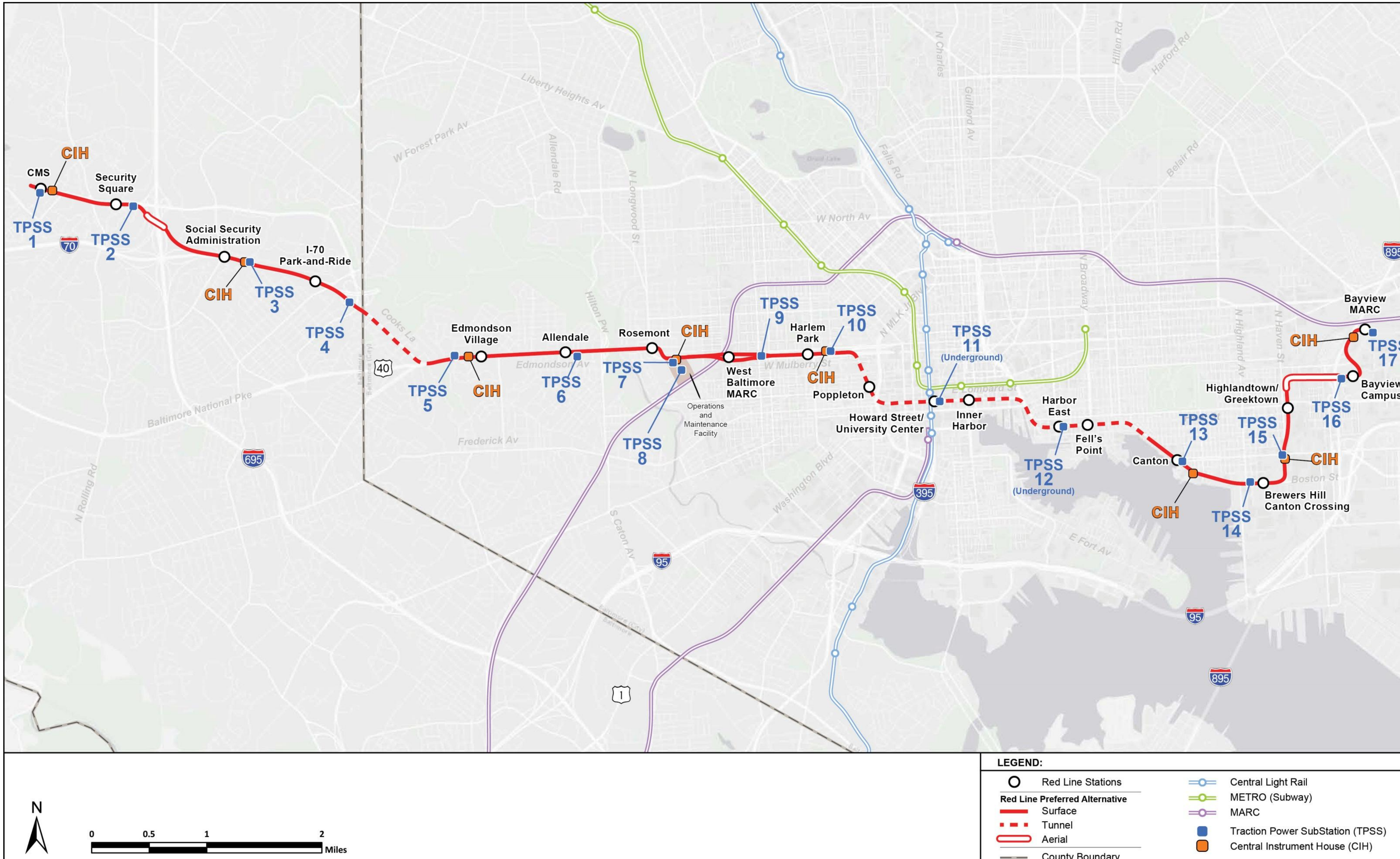


Figure 2: Proposed Locations for Traction Power Substations and Central Instrument Houses along the Red Line Project Study Corridor

2. Environmental Justice

Executive Order 12898 – *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations* requires all Federal agencies to "develop an agency-wide environmental justice strategy that identifies and addresses disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." The United States Department of Transportation (USDOT) and FTA policies on environmental justice are included in USDOT Order 5610.2(a), *Final DOT Environmental Justice Order (USDOT 2012)* and in FTA *Circular 4703.1, Environmental Justice Policy Guidance for Federal Transit Administration Recipients* (FTA 2012).

The strategies developed under Executive Order 12898 and the USDOT and FTA policies on environmental justice are intended to ensure that there is no discrimination based on race, color, or national origin; that communities are provided the opportunity to provide input on the planning and design of a project, as well as potential effects and mitigation measures; and that any disproportionately high and adverse effects on minority or low-income populations are appropriately addressed.

The principles of environmental justice are rooted in Title VI of the Civil Rights Act of 1964, which prohibits discrimination on the basis of race, color and national origin in programs and activities receiving federal financial assistance. Following the direction of EO 12898, federal agencies developed their own strategies to implement environmental justice.

The analysis approach for this report was developed under guidance from USDOT Order 5610.2(a) and FTA Circular 4703.1. Both directives are based on the framework of the National Environmental Policy Act (NEPA), Title VI of the 1964 Civil Rights Act, Uniform Relocation Assistance and Real Property Acquisition of 1970 and the Intermodal Surface Transportation Efficiency Act of 1991.

The USDOT and FTA orders define the fundamental principles of EJ as:

- Avoiding, minimizing or mitigating disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations;
- Ensuring full and fair participation by all potentially affected communities in the transportation decision-making process; and
- Preventing the denial of, reduction in or significant delay in the receipt of benefits by minority and low-income populations (USDOT2012).

The EJ analysis in this report describes the potential human health and environmental effects on minority and low-income neighborhoods that would result from the construction and operation of the Preferred Alternative, and evaluates whether those effects would be disproportionately high and adverse.

2.1 Methodology for Identifying Environmental Justice Populations

Executive Order 12898, itself does not define the terms "minority" or "low-income," but these terms have been defined in the USDOT and FTA orders on environmental justice. The USDOT and FTA orders provide the following definitions, which have been used in this analysis:

- Minority Individual – The US Census Bureau classifies a minority individual as belonging to one of the following groups: American Indian or Alaskan Native, Asian American, Native Hawaiian or Other Pacific Islander, Black (not of Hispanic Origin), and Hispanic or Latino.
- Minority Populations – Any readily identifiable groups of minority persons who live in geographic proximity, and if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who would be similarly affected by a proposed Department of Transportation program, policy, or activity.
- Low-Income Individual – A person whose household income is at or below the United States Department of Health and Human Services poverty guidelines.
- Low-Income Population – Any readily identifiable group of low-income persons who live in geographic proximity, and, if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who would be similarly affected by a proposed FTA program, policy, or activity.

2.1.1 Identifying Minority and Low-Income Populations in the Project Study Area

As a tool for evaluating the proportionality of impacts and benefits, this analysis identifies "EJ areas" and "non-EJ areas" within the project study corridor. An "EJ area" was defined to include any census tract in which the minority or low-income population meets either of the following thresholds:

- (a) the minority or low-income population in the census tract exceeds 50 percent, or
- (b) the percentage of a minority or low-income population in the affected area is "meaningfully greater" than the percentage of minority population in the general population.

For this study, "meaningfully greater" was defined as a census tract in which the percentage of minority or low-income residents was at least 10 percentage points or more than the corresponding percentage in the surrounding jurisdiction (Baltimore City or Baltimore County) within the project study corridor. This use of thresholds for identifying EJ areas was based on the Council on Environmental Quality (CEQ) guidance document, *Environmental Justice Guidance Under the National Environmental Policy Act* (NEPA) (CEQ 1997). This approach was used in the Alternatives Analysis/Draft Environmental Impact Statement (AA/DEIS), which identified EJ and non-EJ areas based on the criteria described above.

On August 15, 2012, FTA issued Circular 4703.1, which does not adopt the CEQ's and instead calls for EJ analyses to include "reasonable efforts to identify the presence of distinct minority and/or low-income communities residing both within, and in close proximity to, the proposed project or activity." The guidance also cautions that, "While the minority or low-income population in an area may be small, this does not eliminate the possibility of a disproportionately high and adverse effect of a proposed action."

For consistency with the approach used in the AA/DEIS, this Final Environmental Impact Statement (FEIS) continues to identify EJ areas based on a threshold approach. In accordance with Circular 4703.1, this FEIS also considers the potential for EJ populations located beyond areas identified as "EJ areas."

2.1.2 Data Sources

- Minority Populations. The US Census 2010 tract level data provided the basis for establishing the location of minority populations in the project study corridor.
- Low-Income Populations. Income data was obtained from the American Community Survey (ACS) 2010 5-year estimate at the census tract level.

Other data sources that were used to identify the location of minority and low-income populations include information and data from the National Center for Educational Statistics (NCES), government-assisted housing programs, historical references, City and County officials, field visits, community meetings and interviews, and a review of revitalization efforts within the project study corridor.

3. Existing Conditions

3.1 Project Study Corridor Boundary

The Red Line project study corridor boundary was defined during the initial conceptual alignment studies prepared for the AA/DEIS. For the AA/DEIS, the project study corridor included all of the location alternatives considered in that study. For the FEIS, the project study corridor was narrowed to focus on the Preferred Alternative. The current project study corridor contains portions of both Baltimore City and Baltimore County. Within the project study corridor there are 55 US Census 2010 tracts: 47 in Baltimore City and 8 in Baltimore County.

3.2 Environmental Justice Populations

The total population in the project study corridor is 162,287 persons, with 117,500 of these persons (72.4 percent) identifying themselves as minorities and 33,798 persons (20.8 percent) meeting the definition of low-income**. Figure 3** presents the EJ areas and non-EJ areas within the project study corridor, and also illustrates the 1,000 foot potential impact area surrounding the project's limit of disturbance. The impact area was used to estimate impacts that extend beyond the limit of disturbance.

Table 1 presents a summary of population data including the percentages for minority and low-income persons. The data revealed that the project study corridor census tracts located within Baltimore County contained a percentage of minority persons (15.5 percent), which is substantially lower than the countywide average of 37.3 percent. For the project study corridor census tracts located in Baltimore City, the minority percentage was 56.9 percent, which is lower than the City average (72.0 percent).

Table 1: Population Statistics

Category	Maryland	Baltimore City	Baltimore County	Project Study Corridor	Baltimore City portion of Project Study Corridor	Baltimore County portion of Project Study Corridor
Total Population	5,773,552	620,961	805,029	162,287	131,336 (80.9%)	30,951 (19.1%)
White Alone[1]	3,157,958 (54.7%)	174,120 (28.0%)	504,556 (62.7%)	44,787 (27.6%)	38,944 (24.0%)	5,843 (3.6%)
Black Alone[1]	1,674,229 (29.0%)	392,938 (63.3%)	206,913 (25.7%)	97,314 (60.0%)	77,346 (47.7%)	19,968 (12.3%)
Asian Alone[1]	316,694 (5.5%)	14,397 (2.3%)	39,865 (5.0%)	5,751 (3.5%)	3,411 (2.1%)	2,340 (1.4%)
Other Alone[1,2]	28,199 (0.5%)	3,018 (0.5%)	3,807 (0.5%)	917 (0.6%)	743 (0.5%)	174 (0.1%)
2 or more races Alone[1]	125,840 (2.2%)	10,528 (1.7%)	16,153 (2.0%)	2,810 (1.7%)	2,066 (1.3%)	744 (0.5%)

Table 1: Population Statistics

Category	Maryland	Baltimore City	Baltimore County	Project Study Corridor	Baltimore City portion of Project Study Corridor	Baltimore County portion of Project Study Corridor
Total Hispanic[3]	470,632 (8.2%)	25,960 (4.2%)	33,735 (4.2%)	10,708 (6.6%)	8,826 (5.4%)	1,882 (1.2%)
Total Minority	**2,615,594 (45.3%)**	**446,841 (72.0%)**	**300,473 (37.3%)**	**117,500 (72.4%)**	**92,392 (56.9%)**	**25,108 (15.5%)**
Low-Income Persons[4,5]	**476,732 (8.3%)**	**127,590 (20.5%)**	**63,465 (7.9%)**	**33,798 (20.8%)**	**31,136 (19.2%)**	**2,662 (1.6%)**

Notes: [1] These categories do not include Hispanic or Latino individuals
[2] Other includes American Indian/ Alaskan Native, Native Hawaiian and Other Pacific Islander and some other race alone
[3] Hispanic can be any race
[4] Poverty status is determined for all people except institutionalized people, people in military group quarters, people in college dormitories, and unrelated individuals under 15 years old (American Fact Finder, factfinder.census.gov).
[5] Because of the unavailability of poverty data from the 2010 US Census, current poverty data has been derived from the American Community Survey (ACS), 5-Year Estimate. Please note that ACS data has a margin of error and does not cover 100% of the geographies used for this report.

Source: US Census 2010, 2010 American Community Survey- 5-Year Estimate

The project study corridor census tracts located within Baltimore County contained a percentage of low-income persons (1.6 percent) that is significantly lower than the countywide average of 7.9 percent. For the project study corridor census tracts located in Baltimore City, the low-income percentage was 19.2 percent which is lower than the City average (20.5 percent). The Baltimore City portion of the project study corridor accounted for 92.1 percent of the total low-income population in the corridor, while the Baltimore County portion is 7.9 percent.

Of the 55 census tracts in the project study corridor, 42 census tracts contain minority populations of 50 percent or more, and 16 census tracts contain low-income populations of 50 percent or more. Fourteen census tracts met the “meaningfully greater” test for the presence of minority or low-income populations but did not meet the 50 percent threshold. **Table 2** and **Figure 3** present the census tracts that meet or exceed the EJ thresholds. Forty-three out of 55 census tracts (78 percent) were identified as minority and/or low-income areas using the 50 percent threshold or the “meaningfully greater” threshold criteria for the presence of a minority population, a low-income population or both. These locations were considered EJ areas for the purposes of the impact analysis. The Gywnns Falls/Leakin Park, Carroll-South Hilton and Pulaski Industrial Area neighborhoods were determined to not have residential dwellings within the 1,000 ft analysis area.

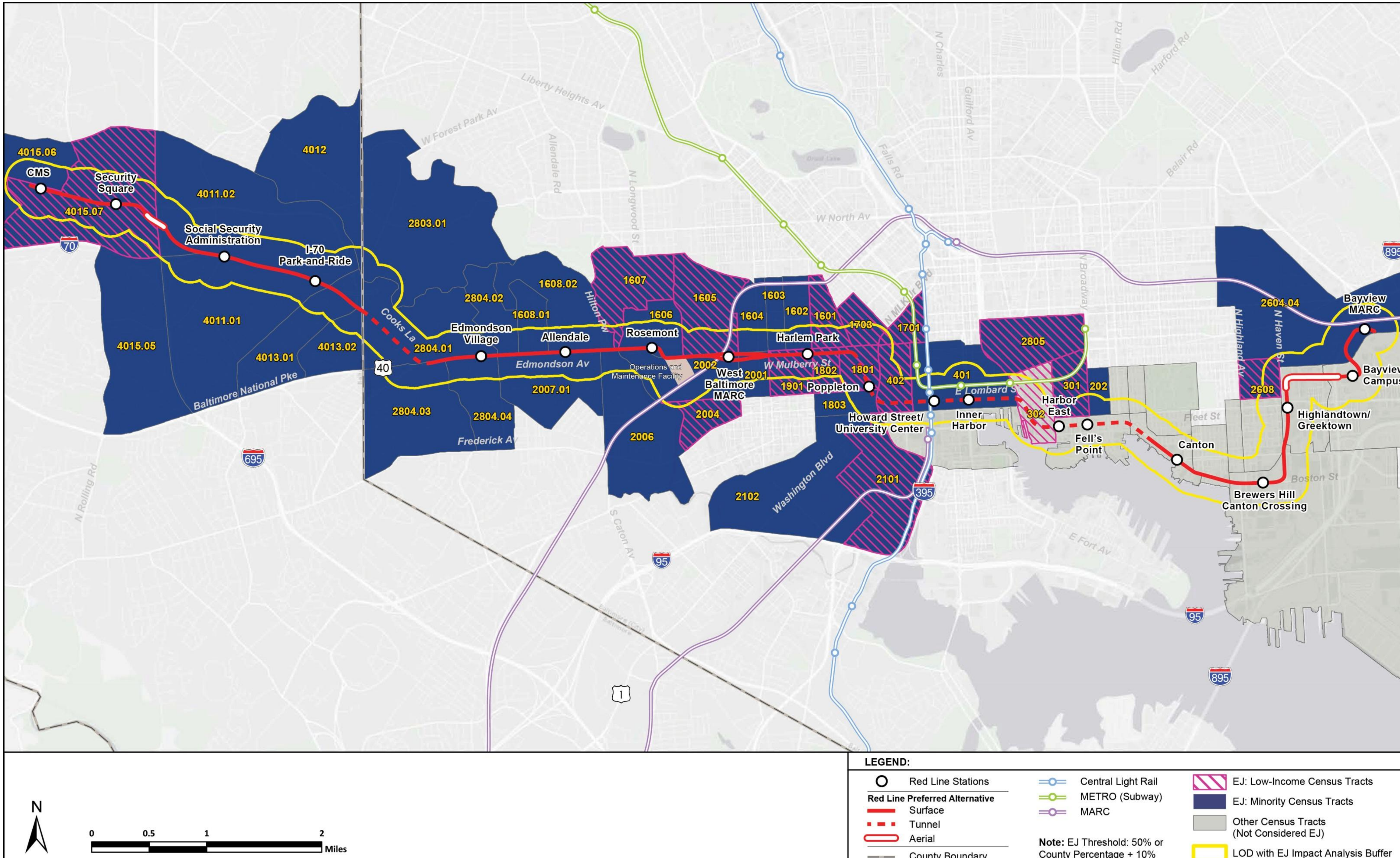


Figure 3: Environmental Justice Areas within the Project Study Corridor

Twelve of the 55 census tracts – located in the Inner Harbor, Fell's Point, Canton, Canton Industrial Area, Brewers Hill, Greektown, and Hopkins Bayview Medical Center neighborhoods – did not meet the criteria for an "EJ area" based on the threshold calculations. However, these areas were reviewed for the presence of minority and low-income populations as defined by USDOT and consistent with the FTA EJ Circular to determine approximate locations and to consider potential effects. The Canton Industrial Area, Greektown, Johns Hopkins Bayview Medical Center and Pulaski Industrial Area neighborhoods were determined not to have residential dwellings within the analysis area. Potential impacts to EJ populations located in the four other "non-EJ areas" (Inner Harbor, Fell's Point, Canton and Brewers Hill) are discussed, as applicable, in **Section 7** and **Section 8**. As used in this chapter, the term "non-EJ area" does not imply the absence of EJ populations living in that area. The distinction between EJ areas and non-EJ areas is used in this report only as one tool for assessing the potential for disproportionate impacts on EJ populations.

Table 2: Project Study Corridor Census Tracts that Meet Environmental Justice Category Definitions

Census Tract	Total	White	% White	Black or African American	% Black or African American	Asian	% Asian	Other	% Other	Two or More Races	% Two or More Races	Hispanic	% Hispanic	Jurisdiction Total Minority %	Total Minority	Total Minority %	EJ Category: Minority?	Jurisdiction Total Low-Income %	Low-Income Population	Census Tract Low-Income %
0101.00	3,022	2,683	88.8%	123	4.1%	65	2.2%	17	0.6%	32	1.1%	102	3.4%	72.0%	339	11.2%	No	20.5%	286	9.7%
0103.00	2,208	1,880	85.1%	84	3.8%	64	2.1%	2	0.1%	24	1.1%	154	7.0%	72.0%	328	14.9%	No	20.5%	11	0.5%
0104.00	2,870	2,404	83.8%	113	3.9%	143	4.7%	11	0.4%	51	1.8%	148	5.2%	72.0%	466	16.2%	No	20.5%	78	4.1%
0105.00	1,724	1,353	78.5%	82	4.8%	52	1.7%	11	0.6%	41	2.4%	185	10.7%	72.0%	371	21.5%	No	20.5%	72	3.3%
0201.00	1,884	1,361	72.2%	180	9.6%	58	1.9%	16	0.8%	30	1.6%	239	12.7%	72.0%	523	27.8%	No	20.5%	653	26.1%
0202.00	2,087	901	43.2%	300	14.4%	132	4.4%	14	0.7%	40	1.9%	700	33.5%	72.0%	1,186	56.8%	Yes	20.5%	482	22.0%
0203.00	3,344	2,698	80.7%	142	4.2%	170	5.6%	20	0.6%	71	2.1%	243	7.3%	72.0%	646	19.3%	No	20.5%	600	20.0%
0301.00	3,065	349	11.4%	2,349	76.6%	83	2.7%	22	0.7%	42	1.4%	220	7.2%	72.0%	2,716	88.6%	Yes	20.5%	995	49.8%
0302.00	2,342	1,193	50.9%	784	33.5%	165	5.5%	9	0.4%	44	1.9%	147	6.3%	72.0%	1,149	49.1%	No	20.5%	891	35.4%
0401.00	4,006	1,844	46.0%	968	24.2%	830	27.5%	29	0.7%	110	2.7%	225	5.6%	72.0%	2,162	54.0%	Yes	20.5%	787	26.3%
0402.00	838	371	44.3%	238	28.4%	168	5.6%	4	0.5%	36	4.3%	21	2.5%	72.0%	467	55.7%	Yes	20.5%	657	59.0%
1601.00	2,388	34	1.4%	2,280	95.5%	12	0.4%	3	0.1%	26	1.1%	33	1.4%	72.0%	2,354	98.6%	Yes	20.5%	1,205	49.5%
1602.00	2,515	26	1.0%	2,424	96.4%	8	0.3%	9	0.4%	39	1.6%	9	0.4%	72.0%	2,489	99.0%	Yes	20.5%	807	30.9%
1603.00	1,558	27	1.7%	1,503	96.5%	0	0.0%	3	0.2%	9	0.6%	16	1.0%	72.0%	1,531	98.3%	Yes	20.5%	333	20.0%
1604.00	2,525	21	0.8%	2,453	97.1%	9	0.3%	7	0.3%	26	1.0%	9	0.4%	72.0%	2,504	99.2%	Yes	20.5%	951	28.3%
1605.00	4,245	21	0.5%	4,113	96.9%	5	0.2%	15	0.4%	57	1.3%	34	0.8%	72.0%	4,224	99.5%	Yes	20.5%	1,280	34.5%
1606.00	3,509	23	0.7%	3,388	96.6%	11	0.4%	8	0.2%	27	0.8%	52	1.5%	72.0%	3,486	99.3%	Yes	20.5%	679	21.5%
1607.00	5,615	32	0.6%	5,433	96.8%	4	0.1%	16	0.3%	84	1.5%	46	0.8%	72.0%	5,583	99.4%	Yes	20.5%	2,370	42.4%
1608.01	3,281	25	0.8%	3,169	96.6%	2	0.1%	3	0.1%	56	1.7%	26	0.8%	72.0%	3,256	99.2%	Yes	20.5%	500	14.9%
1608.02	3,045	21	0.7%	2,955	97.0%	1	0.0%	22	0.7%	24	0.8%	22	0.7%	72.0%	3,024	99.3%	Yes	20.5%	711	22.8%
1701.00	1,602	309	19.3%	1,180	73.7%	30	1.0%	7	0.4%	34	2.1%	42	2.6%	72.0%	1,293	80.7%	Yes	20.5%	705	39.4%
1703.00	2,011	17	0.8%	1,909	94.9%	18	0.6%	9	0.4%	27	1.3%	31	1.5%	72.0%	1,994	99.2%	Yes	20.5%	812	45.6%
1801.00	2,200	18	0.8%	2,127	96.7%	2	0.1%	6	0.3%	23	1.0%	24	1.1%	72.0%	2,182	99.2%	Yes	20.5%	855	38.4%
1802.00	977	55	5.6%	903	92.4%	2	0.1%	3	0.3%	8	0.8%	6	0.6%	72.0%	922	94.4%	Yes	20.5%	404	40.0%

Table 2: Project Study Corridor Census Tracts that Meet Environmental Justice Category Definitions

Census Tract	Total	White	% White	Black or African American	% Black or African American	Asian	% Asian	Other	% Other	Two or More Races	% Two or More Races	Hispanic	% Hispanic	Jurisdiction Total Minority %	Total Minority	Total Minority %	EJ Category: Minority?	Jurisdiction Total Low-Income %	Low-Income Population	Census Tract Low-Income %
1803.00	1,909	574	30.1%	1,184	62.0%	45	1.5%	13	0.7%	38	2.0%	55	2.9%	72.0%	1,335	69.9%	Yes	20.5%	506	30.4%
1901.00	1,895	30	1.6%	1,747	92.2%	2	0.1%	15	0.8%	24	1.3%	77	4.1%	72.0%	1,865	98.4%	Yes	20.5%	867	39.9%
2001.00	1,846	32	1.7%	1,745	94.5%	2	0.1%	7	0.4%	30	1.6%	30	1.6%	72.0%	1,814	98.3%	Yes	20.5%	472	23.4%
2002.00	2,969	36	1.2%	2,876	96.9%	6	0.2%	13	0.4%	26	0.9%	12	0.4%	72.0%	2,933	98.8%	Yes	20.5%	910	31.1%
2004.00	1,691	44	2.6%	1,611	95.3%	4	0.1%	4	0.2%	20	1.2%	8	0.5%	72.0%	1,647	97.4%	Yes	20.5%	806	48.1%
2006.00	2,713	706	26.0%	1,879	69.3%	19	0.6%	8	0.3%	39	1.4%	62	2.3%	72.0%	2,007	74.0%	Yes	20.5%	831	26.4%
2007.01	4,619	22	0.5%	4,517	97.8%	6	0.2%	10	0.2%	34	0.7%	30	0.6%	72.0%	4,597	99.5%	Yes	20.5%	561	13.1%
2101.00	2,130	818	38.4%	1,108	52.0%	66	2.2%	18	0.8%	54	2.5%	66	3.1%	72.0%	1,312	61.6%	Yes	20.5%	712	34.8%
2102.00	3,373	1,331	39.5%	1,590	47.1%	226	7.5%	20	0.6%	83	2.5%	123	3.6%	72.0%	2,042	60.5%	Yes	20.5%	720	19.8%
2201.00	4,025	2,976	73.9%	587	14.6%	233	7.7%	28	0.7%	75	1.9%	126	3.1%	72.0%	1,049	26.1%	No	20.5%	724	19.5%
2604.04	1,996	534	26.8%	576	28.9%	78	2.6%	29	1.5%	42	2.1%	737	36.9%	72.0%	1,462	73.2%	Yes	20.5%	301	17.2%
2605.01	4,875	3,005	61.6%	337	6.9%	172	5.7%	37	0.8%	104	2.1%	1,220	25.0%	72.0%	1,870	38.4%	No	20.5%	610	15.3%
2606.05	4,795	2,713	56.6%	784	16.4%	99	3.3%	85	1.8%	111	2.3%	1,003	20.9%	72.0%	2,082	43.4%	No	20.5%	1,044	20.5%
2607.00	2,260	1,174	51.9%	197	8.7%	26	0.9%	18	0.8%	31	1.4%	814	36.0%	72.0%	1,086	48.1%	No	20.5%	438	19.0%
2608.00	2,647	1,053	39.8%	456	17.2%	44	1.5%	30	1.1%	58	2.2%	1,006	38.0%	72.0%	1,594	60.2%	Yes	20.5%	1,017	36.8%
2609.00	2,652	2,128	80.2%	105	4.0%	82	2.7%	34	1.3%	39	1.5%	264	10.0%	72.0%	524	19.8%	No	20.5%	186	8.1%
2611.00	1,951	1,632	83.6%	83	4.3%	53	1.8%	13	0.7%	43	2.2%	127	6.5%	72.0%	319	16.4%	No	20.5%	58	4.1%
2803.01	4,101	335	8.2%	3,601	87.8%	19	0.6%	26	0.6%	43	1.0%	77	1.9%	72.0%	3,766	91.8%	Yes	20.5%	817	20.0%
2804.01	3,565	491	13.8%	2,956	82.9%	22	0.7%	9	0.3%	45	1.3%	42	1.2%	72.0%	3,074	86.2%	Yes	20.5%	475	12.7%
2804.02	1,574	14	0.9%	1,515	96.3%	3	0.1%	4	0.3%	15	1.0%	23	1.5%	72.0%	1,560	99.1%	Yes	20.5%	126	6.9%
2804.03	5,073	1,273	25.1%	3,551	70.0%	52	1.7%	31	0.6%	92	1.8%	74	1.5%	72.0%	3,800	74.9%	Yes	20.5%	453	8.4%
2804.04	2,267	112	4.9%	2,100	92.6%	7	0.2%	10	0.4%	19	0.8%	19	0.8%	72.0%	2,155	95.1%	Yes	20.5%	456	21.4%
2805.00	3,549	245	6.9%	3,041	85.7%	111	3.7%	15	0.4%	40	1.1%	97	2.7%	72.0%	3,304	93.1%	Yes	20.5%	922	53.9%
4011.01	6,487	1,343	20.7%	4,203	64.8%	315	10.4%	28	0.4%	142	2.2%	456	7.0%	37.3%	5,144	79.3%	Yes	7.9%	249	4.1%
4011.02	962	147	15.3%	671	69.8%	78	2.6%	4	0.4%	22	2.3%	40	4.2%	37.3%	815	84.7%	Yes	7.9%	109	9.6%

Table 2: Project Study Corridor Census Tracts that Meet Environmental Justice Category Definitions

Census Tract	Total	White	% White	Black or African American	% Black or African American	Asian	% Asian	Other	% Other	Two or More Races	% Two or More Races	Hispanic	% Hispanic	Jurisdiction Total Minority %	Total Minority	Total Minority %	EJ Category: Minority?	Jurisdiction Total Low-Income %	Low-Income Population	Census Tract Low-Income %
4012.00	3,270	721	22.0%	2,276	69.6%	35	1.2%	12	0.4%	87	2.7%	139	4.3%	37.3%	2,549	78.0%	Yes	7.9%	251	7.0%
4013.01	3,891	777	20.0%	2,751	70.7%	98	3.2%	19	0.5%	55	1.4%	191	4.9%	37.3%	3,114	80.0%	Yes	7.9%	266	7.0%
4013.02	2,650	365	13.8%	2,136	80.6%	25	0.8%	17	0.6%	36	1.4%	71	2.7%	37.3%	2,285	86.2%	Yes	7.9%	216	8.8%
4015.05	4,039	1,292	32.0%	1,802	44.6%	490	16.2%	37	0.9%	105	2.6%	313	7.7%	37.3%	2,747	68.0%	Yes	7.9%	271	7.5%
4015.06	4,523	569	12.6%	3,193	70.6%	385	12.7%	21	0.5%	145	3.2%	210	4.6%	37.3%	3,954	87.4%	Yes	7.9%	215	4.0%
4015.07	5,129	629	12.3%	2,936	57.2%	914	30.2%	36	0.7%	152	3.0%	462	9.0%	37.3%	4,500	87.7%	Yes	7.9%	1,085	20.3%

Note: For the purposes of this table, the Environmental Justice (EJ) categories are "Low-income" and "Minority". A "Yes" value indicates that the census tract meets the requirements for classification as an EJ census tract for that category. As previously stated, if the minority or low-income population percentage meets or exceeds either the 50% threshold or the meaningfully greater 10% threshold, the census tract is considered an EJ census tract.

Source: US Census 2010

4. Supplemental Data

The US Census 2010 data provided the basic reference for establishing the location of EJ populations in the project study area. To corroborate the findings of the research and to support future public outreach activities, supplemental sources were consulted regarding minority and low-income populations within the project study area. This information was also used to develop specific targeted outreach activities within the Preferred Alternative corridor as well. The supplemental sources are described below.

4.1 National Center for Educational Statistics (NCES)

NCES provides relatively recent demographic information for the public school student population for project study area schools. Its 2007-2008 Common Core of Data provides racial composition and the number of students who are eligible for free or reduced lunches for each public school. The 2009-2010 public school enrollments by race and ethnicity table were also reviewed to determine demographic trends. Elementary schools were identified as being most representative of their surrounding area because they have set boundaries and encompass the smallest possible geographic area. However, zone middle school data was reviewed as well. In general, the data from NCES was consistent with the 2010 census data for the households in the Red Line corridor that would have school aged children eligible to participate in free and reduced lunch program in the applicable age categories at the elementary and middle school level. The data did reveal an increase in Hispanic populations in local neighborhood schools serving the Fell's Point and Highlandtown/Greektown station areas.

4.2 Government Assisted Housing Programs

Within the project study areas, the US Department of Housing and Urban Development (HUD), the Housing Authority of Baltimore City (HABC) and the Baltimore County Housing Office (BCHO) provide housing assistance for low-income persons. There are typically two key programs used to provide housing options for low-income, disabled and elderly populations, those include public housing and the Housing Choice Voucher Program known as Section 8. Public Housing units are generally constructed, maintained and operated by a local housing authority. The Section 8 program allows grantees to use vouchers in privately owned homes and apartment complexes that are not operated and maintained by a local housing authority.

Healthy Communities Environmental Maps were reviewed through HUD's Enterprise Geographic Information System; these maps provide the location and type of HUD activity, including the location of HUD-established Empowerment Zones. The affordable housing unit tables for Baltimore City and Baltimore County were also reviewed to determine the location of subsidized housing units that are managed by HABC and Department of Housing and Community Development (DHCD), and other services within the project study area. In Baltimore County, BCHO does not operate public housing developments; residents must use the Section 8 program. In general, the locations of subsidized housing units were in census tracts that met the criteria for a low-income population during the 2000 Census and the ACS 5-year estimate. Of the 49 HABC public housing developments or HABC contracted units within privately-run housing developments, approximately seven are located within the EJ impact analysis area and three within the project limit of disturbance. All public housing units within the exception of one development are located west of downtown Baltimore City. The information was also consistent with the corridor reviews that have been completed to date. It should be noted that there was a decrease in the overall number of available public housing units within the Baltimore City and there has also been a net decrease in available Section 8 units in Baltimore City, within the project study area (HABC 2012). A waitlist is available for parties seeking housing.

4.3 Historical References

The project study area includes several traditional African-American neighborhoods, with sites including housing, stores, churches and community gathering places. References used included Maryland's Sailor Inventory of African-American Historical and Cultural Resources, Baltimore County Historical Society and Public Library Legacy Web, Baltimore's African-American Heritage and Attractions Guide, and local citizens. The Sailor Inventory identifies locations of African-American sites including towns, neighborhoods, cemeteries, archaeological sites, historic markers and churches. These references revealed that many of the sites that were identified in the project study area are in EJ locations. These findings have been used to support current outreach efforts and will continue to be a source for future outreach efforts.

4.4 Field Visits, Meetings, and Interviews

Field visits consisted of: driving and walking areas of the Preferred Alternative; door-to-door outreach; small group meetings; distributing project information at community and neighborhood events through the Red Line Community Liaisons and other public involvement team members; and attending project meetings and open houses. While visiting potential EJ population areas, the project team spoke with community members regarding their community's characteristics, obtained information regarding emerging populations and other resources. The information gathered helped project team members confirm the location of minority populations and to identify additional needs and concerns, pockets of population dispersion not captured in the 2010 Census, and to assist the Red Line Community Liaisons with the development of grassroots outreach plans for the project.

4.5 Revitalization Efforts

Throughout the project study area, and especially in Baltimore City, revitalization has been occurring. Websites, such as the Live Baltimore, Housing Authority of Baltimore City and the Baltimore Development Corporation provided information on the development changes throughout the project study area. These websites revealed that several of the project study corridor block groups, most notably within the neighborhoods of Sandtown, Poppleton, Harlem Park, Uplands and Jonestown, are the focus of revitalization efforts.

Many old public housing developments are being replaced by newer, mixed-income HOPE VI developments. However, it should be noted the HOPE VI program grants have ended for future project consideration. For example, the Uplands development, located on the south side of Edmondson Avenue in the Edmondson Village neighborhood, a 100-acre site, is currently under construction for the first phase of development (63 acres). The apartment homes associated with Phase I opened in August 2012. At full development, the Uplands development would include 761 mixed-income residential units.

Other revitalization efforts include the expansion of the University of Maryland Biotechnology Park and construction of offices, hotels and condominiums, which are changing the landscape of downtown. Baltimore City also launched its "Vacants to Value" Home Buyer program which is encouraging the redevelopment of blighted neighborhoods within the project study area. As a result of these revitalization efforts, the demographics of neighborhoods located in these EJ areas are expected to continue to change. However, it should be noted that the foreclosure crisis has stalled development in several areas in the project corridor.

5. Environmental Justice Impact Analysis

The analysis considered the potential project impacts that would directly affect the project study area census tracts. The location and severity of anticipated impacts associated with the Preferred Alternative were used to determine if environmental justice populations could be disproportionately or adversely impacted.

5.1 Affected Area

The project study corridor for the Preferred Alternative includes all or parts of 55 US census tracts. Forty-three of these 55 census tracts (78 percent) meet one or both of the established thresholds for environmental justice populations. The project impacts for these EJ areas were determined and are presented along with the corresponding census tract information and neighborhood names as applicable in the project study area. The Baltimore City neighborhood boundaries are based upon Neighborhood Statistical Areas (NSAs) as defined by Baltimore City. The neighborhoods located in Baltimore County consist of groups of census tracts that collectively represent a community, as determined by the Baltimore County Department of Planning. These neighborhoods are now reported as two neighborhood groupings Windsor Mill and Gwynn Oak versus individual neighborhoods as referenced in the AA/DEIS. **Table 3** lists the census tracts and corresponding neighborhoods in the project study area.

Table 3: EJ Neighborhoods and US Census Tracts

Neighborhood	Corresponding US Census Tracts
Allendale	2007.01
Carroll-South Hilton	2006.00
Downtown	0401.00, 0402.00
Edmondson Village	1608.01, 1608.02
Franklin Square	1901.00, 2001.00
Franklintown Road	1606.00, 1607.00
Gwynn Oak	4011.01, 4011.02, 4012.00, 4013.01, 4013.02
Gywnns Falls/Leakin Park	1607.00, 1608.02, 2803.01, 2804.02
Harlem Park	1601.00, 1602.00, 1603.00, 1604.00, 1801.00, 1802.00, 1901.00, 2001.00
Heritage Crossing	1703.00, 1801.00
Highlandtown	2608.00, 2609.00, 2611.00
Hollins Market	1803.00
Hunting Ridge	2804.01
Inner Harbor	0302.00, 0401.00, 2201.00
Jonestown	0302.00, 2805.00
Kresson	2604.04
Little Italy	0301.00, 0302.00
Midtown-Edmondson	1604.00, 1605.00, 2001.00
Mosher	1606.00
Penrose/Fayette Street Outreach	1606.00, 2001.00, 2002.00
Pulaski Industrial Area	2604.04
Poppleton	1801.00, 1802.00
Rognel Heights	2804.01, 2804.02
Rosemont Homeowners/Tenants	1605.00, 1606.00
Ten Hills	2804.03
University of Maryland	0402.00
Uplands	2804.04
West Hills	2804.01
Westgate	2804.03
Windsor Mill	4015.05, 4015.06, 4015.07

Sources: Baltimore County Planning Department
Baltimore's Neighborhoods Statistical Areas Map (with 2010 Census Tracts)

6. Future No-Build Conditions

The No-Build Alternative would consist of a future scenario with no changes to transportation services or facilities within the project corridor, beyond the projects that are included in the Baltimore region's financially constrained long-range transportation plan (CLRP).

Most of the impact analyses in this FEIS identified few effects to EJ populations under the No-Build Alternative. However, the results of the EJ analysis showed there would be negative effects under the No-Build Alternative in comparison to existing conditions with regard to delays at intersections, as well as travel times throughout the project study corridor. Under the No-Build Alternative, the overall traffic levels-of-service (LOS) would worsen from the existing conditions throughout the entire project study corridor, including those within EJ areas, as a result of traffic volume growth in the region between 2011 and 2035. In addition, travel times are expected to increase under the No-Build Alternative, and mobility is expected to decrease within the project study corridor. The current roadway and transit systems would not be able to accommodate the population growth associated with the new development; therefore, service levels are expected to worsen. In addition, under the No-Build Alternative, EJ populations would not benefit from enhanced access to transit that would be associated with the implementation of the Preferred Alternative. As such, transit dependent EJ populations would continue to endure long commutes in the east-west direction and increased headways for transit trips.

7. Long-Term Operational Effects in EJ Areas

The Preferred Alternative is expected to be constructed and in service by 2021. This section identifies long-term operational effects of the Preferred Alternative relative to design year 2035 on EJ populations.

7.1 Long-Term Effects from Property Acquisition

Property impacts are assessed by determining if a transportation improvement requires the purchase of land outside of existing public right-of-way or includes easement on the property. There would be property acquisitions required to obtain the land parcels necessary for the construction of the OMF, tunnel vent facilities, and TPSSs. Property impacts have been minimized by including tunnel sections along Cooks Lane and in the Downtown segment of the project. Any property that is acquired in full, or a property where the access is eliminated because of the Preferred Alternative, is considered a displacement. The Preferred Alternative would require no property acquisitions that result in residential displacements. A total of 23 displacements and 169 partial property acquisitions are required corridor-wide. The 23 displacements all involve non-residential properties. Of the 169 partial property acquisitions corridor-wide, 101 are residential properties. Of the 101 residential partial property acquisitions required, 97 are located in EJ areas. Eighty-seven of these residential property acquisitions are along Edmondson Avenue between Wildwood Parkway and North Hilton Street, and ten of the properties are along West Franklin Street, and involve “sliver takes” totaling 7,321 square feet, and an average of 84 square feet per property. The majority of the residential partial property acquisitions required in EJ areas are from single-family residential properties or single-family properties that may have been converted to multi-family units.

In most cases, the partial property acquisitions in EJ areas would consist of a narrow strip or “sliver” of land along the edge of the alignment of the Preferred Alternative and would necessitate the reconfiguration of existing front yards and/or steps in several EJ areas. The neighborhood with the highest number of such impacts is the Allendale neighborhood (Census Tracts 2007.01). These impacts include the partial acquisition of 87 residential properties along Edmondson Avenue between Wildwood Parkway and North Hilton Street. Ten additional residential partial property acquisitions would be required along West Franklin Street in the Rosemont Homeowners/Tenants neighborhood (Census Tract 1605.00). The property would be used to provide a dedicated lane for the Preferred Alternative along Edmondson Avenue.

Twelve non-residential displacements along North Franklintown Road and Calverton Road, which likely include minority-owned businesses and property owned by government and institutional entities, are required to construct the guideway and the OMF site. In addition, 17 commercial and institutional parcels along West Franklin Street would require partial property acquisitions. One of these 17 parcels located along West Franklin Street, currently houses a daycare facility and a restaurant.

The project would require permanent subsurface easements for the Cooks Lane and Downtown Tunnel segments. These subsurface easements include 75 properties located in the West Hills, Hunting Ridge, Poppleton and Downtown neighborhoods, which are located in Census Tracts 2804.01, and 1801.00, 1802.00 and 0401.00, respectively.

During the acquisition process, impacts to minority business owners and residents would be determined and addressed throughout the corridor. As stated above, 97 of the 102 residential partial property acquisitions required for the Preferred Alternative are located in EJ areas. Although entrances and steps would be re-constructed at these locations, land parcels purchased would become part of the public right-of-way for transportation use.

Table 4 summarizes the property impacts by census tract (and corresponding EJ neighborhoods). Census tract 2007.01 (Allendale neighborhood) would experience the largest number of properties from which right-of-way is required. However, the total amount of property required from Census Tract 2007.01 is less than 15,500 square feet.

In Baltimore County, Census Tracts 4011.01, 4011.02, 4012.00, 4013.01 and 4013.02 (Gwynn Oak neighborhood) and Census Tracts 4015.05, 4015.06 and 4015.07 (Windsor Mill neighborhood) would experience property acquisition. Appendix K of the FEIS contains more detailed information on property impacts.

Table 4: Property Impacts By Census Tract and Corresponding EJ Neighborhood (number/square feet)

Census Tract	EJ Neighborhood	Fee Simple / Property Acquisitions	Permanent Easements
4015.05 4015.06 4015.07	Windsor Mill	10 (235,537)	5 (109,706)
4011.01 4011.02 4012.00 4013.01 4013.02	Gwynn Oak	1 (45,524)	6 (210,855)
2804.01	West Hills	0	20 (3,714)
2804.03	Westgate	0	0
2804.03	Ten Hills	0	0
2804.01	Hunting Ridge	1 (4,968)	7 (10,474)
2804.01 2804.02	Rognel Heights	0	0
2804.04	Uplands	1 (17,683)	0
2007.01	Allendale	95 (15,065)	0
1608.01 1608.02	Edmondson Village	0	0
1607.00 1608.02 2803.01 2804.02	Gywnns Falls/Leakin Park	0	0
2006.00	Carroll-South Hilton	0	0
1606.00 1607.00	Franklintown Road	0	0

Table 4: Property Impacts By Census Tract and Corresponding EJ Neighborhood (number/square feet)

Census Tract	EJ Neighborhood	Fee Simple / Property Acquisitions	Permanent Easements
1606.00	Mosher	0	0
1606.00 2001.00 2002.00	Penrose/Fayette Street Outreach	26 (863,792)	0
1605.00 1606.00	Rosemont Homeowners/Tenants	24 (10,179)	0
1604.00 1605.00 2001.00	Midtown-Edmondson	0	0
1601.00 1602.00 1603.00 1604.00 1801.00 1802.00 1901.00 2001.00	Harlem Park	0	0
1901.00 2001.00	Franklin Square	0	0
1801.00 1802.00	Poppleton	8 (8,914)	10 (1,015)
1703.00 1801.00	Heritage Crossing	0	0
1803.00	Hollins Market	0	2 (485)
0402.00	University of Maryland	0	3 (19,485)
0401.00 0402.00	Downtown	3 (57,895)	
0302.00 0401.00 2201.00	Inner Harbor	1 (51,000)	8 (14,680)
0302.00 2805.00	Jonestown	0	0
0301.00 0302.00	Little Italy	0	1 (13,925)
2604.04	Kresson	0	0
2604.04	Pulaski Industrial Area	0	0

7.2 Long-Term Effects on Neighborhood Cohesion and Isolation

Impacts on neighborhood cohesion were assessed by determining potential disruption in the interaction among persons and groups within a community, the use of community facilities, residential stability, and length of time residents have resided in the community. These impacts may occur because of a physical barrier, substantial change in land use, displacements or other effects of a project.

The Preferred Alternative would be located along existing roadways that border communities where possible to integrate the project into the transportation network. The central location would improve accessibility and, in turn, encourage more pedestrian and bicycle travel. The stations are strategically located along existing thoroughfares and would create an activity node within the community, not a means of isolation. Pathways and accessible routes connecting to each station for all modes would be provided and integrated into the typography of the sites. Ramps, elevators and stairs would be incorporated, as required, for access.

Normal surface operation of the Preferred Alternative would not impact neighborhood cohesion. In areas where fencing and guardrails are required for safety reasons around the guideway and as part of the station design, pedestrian crossing areas would be included. These increased mobility options are a benefit to EJ neighborhoods and would help to promote cohesion and reduce isolation.

Details on long-term impacts to cohesion and isolation are provided for each of the five segments below. During construction, traffic patterns for vehicles, pedestrians and bicycles would be temporarily modified in the areas surrounding the new light rail tunnel portals, and other associated improvements; however, once completed, the Preferred Alternative would not affect cohesion or create isolation.

7.2.1 West Segment

The Preferred Alternative within the West segment, which is an EJ area, is located primarily within existing roadway right-of-way. Pedestrians would be able to safely and easily cross the light rail tracks at several signalized crosswalks at intersections and near proposed stations.

7.2.2 Cooks Lane Tunnel Segment

The Preferred Alternative travels under Cooks Lane in EJ Census Tract 2804.01 (West Hills/Hunting Ridge) and continues to Edmondson Avenue in Census Tract 2804.3 (Ten Hills); however, since the alignment would be located entirely underground in these areas, the Preferred Alternative would not affect community cohesion. There would be no physical barriers on the surface that would separate or isolate parts of the community. The tunnel portals would be located on the surface; however, both portals are located within existing transportation right-of-way and would not affect cohesion or create isolation within the community. The selection of an underground alternative was reached as a result of community input in this sensitive area. The potential for barriers does exist around the portal locations and during construction of those portals.

7.2.3 US 40 Segment

The western portion of the US 40 segment, also an EJ area, would be located along Edmondson Avenue, within existing right-of-way. This portion of the alignment is located in the median between several neighborhood boundaries. Access north and south across Edmondson Avenue would be maintained for pedestrians. This is important, in part, because of the new Uplands residential development in Census Tract 2804.04 (Uplands) and the location of the Edmondson-Westside High School and Edmondson-Westside Skill Center in Census Tract 2007.01 (Allendale). Safe crossing points would be established at major intersections and near proposed stations.

The OMF site would be located in Census Tract 2002.00 (Penrose/Fayette Street Outreach). The selection of this site has the potential to impact the surrounding neighborhoods in a variety of ways including wheel squeaks, lighting, ground-borne and operational noise and several property impacts. The residential units located to the west of the site are largely vacant and include several industrial uses. The existing businesses that are located within the footprint of the OMF site do not include community destinations. Therefore, the Preferred Alternative would not have an effect on neighborhood cohesion or create isolation in the vicinity of the OMF.

Between the existing MARC rail station and Smallwood Street, there would be an at-grade, split side platform station. There would be one platform adjacent to Franklin Street and one platform adjacent to Mulberry Street. Located east of Monroe Street, TPSS-9 would be located in Census Tract 1603.00 (Harlem Park) between the split guideway in the grass median of US 40. There would be a center platform station at grade with US 40, and between and below the grade of Calhoun Street and Carey Street.

The Preferred Alternative would be located within a wide swath of right-of-way currently used by US 40, and bounded by West Franklin and West Mulberry Streets. The existing roadway in this section is below grade, creating a barrier that runs east to west for several blocks and can only be crossed at existing overpasses. Currently pedestrians crossing north and south use the existing pedestrian and roadway bridges. The Preferred Alternative would not affect the north-south travel of pedestrians across US 40 since these movements occur along existing overpasses. Pedestrians, bicyclists, (and motorists) would continue to have unobstructed north-south crossings available at the overpasses.

7.2.4 Downtown Tunnel Segment

Portions of the Downtown Tunnel segment are located in EJ areas consisting of Census Tract 1801.00 (Poppleton); Census Tract 1803.00 (Hollins Market), Census Tracts 0401.00 and 0402.00 (Downtown), and Census Tract 0302.00 (Little Italy); however, the Preferred Alternative would be located entirely underground in these areas. All potential stations (Poppleton, Howard Street/University Center, Charles Center/Government Center, Harbor East and Fell’s Point Stations) would be underground, but there would be station entrances and ancillary structures at street level.

The construction of the portal areas would create barriers during the anticipated 3 to 5 year construction period. However, after construction, the only barriers would be located around the portals and any fenced areas around the stations for traffic and flow control.

7.2.5 East Segment

The Preferred Alternative would continue to its terminus at the Bayview MARC Station in Census Tract 2604.04 (Pulaski Industrial Area). The Preferred Alternative would not create a new barrier or separation that does not currently exist in this segment and existing pedestrian movements would be maintained. Safe crossings would be provided near intersections and at proposed stations. The Fell's Point and Highlandtown/Greektown stations would be located in "main street" commercial areas contributing to the accessibility of residents and providing connectivity for Hispanic populations traveling to these emerging community centers from other areas in the city.

7.3 Long-Term Effects on the Roadway and Transit Network

Building the Red Line light rail transit (LRT) system would require that changes be made to a number of roadways along the Preferred Alternative corridor. This would allow for transit to operate in exclusive lanes and provide a time advantage to transit vehicles. Besides reducing the number of traffic lanes, street patterns may be modified in a number of other ways. This includes regulating new turn restrictions, closing some accesses, and removing or installing new traffic signals at several intersections along the Preferred Alternative where the LRT crosses high volume side streets.

To construct the Preferred Alternative with minimal property impacts, the number of traffic lanes must be reduced along 13 roadway pairs or segments. This reduction would allow for transit to operate in exclusive lanes. Lane closures traversing 19 EJ areas along 12 of these roadway pairs or segments include Security Boulevard, I-70, Edmondson Avenue, West Franklin Street, Franklintown Road, and the US 40 generally result in the net loss of one travel lane in the east or westbound direction. Travel lanes (ranging from one to three lanes in each direction) would be maintained after the reduction of the above noted travel lanes in these areas. These impacts serve to improve transit operations through the provision of a dedicated travel lane and provide a travel time advantage to transit vehicles.

Please refer to the *Traffic and Parking Technical Report* for more detailed information. **Table 5** identifies the roadways that would experience a reduction because of the allocation of exclusive lanes for the Preferred Alternative.

Table 5: Number of Lanes: 2035 No-Build vs. the Preferred Alternative

Census Tract	Neighborhood	Geographic Limits	Description	2035 No-Build Number of Lanes	2035 Preferred Alt. Number of Lanes	Change
4015.07	Windsor Mill	Security Boulevard from CMS to Rolling Road	Dedicated transit on south side of Security Boulevard, two traffic lanes eastbound and westbound, in each direction	2EB 2WB	2EB 2WB	No Change
		Security Boulevard from Rolling Road to Lord Baltimore Drive	Dedicated transit on south side of Security Boulevard, two traffic lanes eastbound and three traffic lanes westbound.	3EB 3WB	2EB 3WB	-1EB
		Security Boulevard form Lord Baltimore Drive to I-695	Dedicated transit on south side of Security Boulevard, three traffic lanes, eastbound and westbound, in each direction.	3EB 3WB	3EB 3WB	No change
4011.02	Gwynn Oak	Over and across I-695 Lanes/Ramps	Aerial transit structure across I-695 ramps.	N/A	N/A	No change
		I-70 ramps	Dedicated transit on north-side of westbound I-70 off-ramps onto I-695 and south side of Social Security Administration's west side of Parking lot.	2EB 3 to 1WB	2 to 3EB 3 to 1WB	+1EB
		I-70	Dedicated transit on north side of I-70 from Woodlawn Drive to Parallel Drive.	4EB 3WB	3EB 3WB	-1EB
		I-70	Dedicated transit on north side of I-70 from Parallel Drive to Forest Park Avenue/Cooks Lane.	3 to 1EB 1 to 2WB	1EB 1 to 2WB	-2EB No Change WB
2804.01 2804.03	West Hills Ten Hills	Cooks Lane from Forest Park Avenue to Edmondson Avenue	Underground transit system from Forest Park Avenue to Edmondson Avenue.	1EB 1WB	1EB 1WB	No Change
		Edmondson Avenue from Cooks Lane to Glen Allen Drive	Underground tunnel from Cooks Lane to Glen Allen Drive.	3EB 3WB	2EB 2WB	-1EB -1WB

Table 5: Number of Lanes: 2035 No-Build vs. the Preferred Alternative

Census Tract	Neighborhood	Geographic Limits	Description	2035 No-Build Number of Lanes	2035 Preferred Alt. Number of Lanes	Change
2804.01 2804.04 2804.02 2007.01 1608.01 1608.02 2006.00 1606.00 2002.00	Hunting Ridge Uplands Rognel Heights Allendale Edmondson Village Gwynns Falls/Leakin Park and Edgewood Carroll-South Hilton Franklintown Penrose/Fayette Street Outreach	Edmondson Avenue from Glen Allen Drive to North Franklintown Road	Dedicated transit in the median that will reduce one lane in each direction.	3EB 3WB	2EB 2WB	-1EB -1WB
1606.00 2002.00	Franklintown Penrose/Fayette Street Outreach	North Franklintown Road from Edmondson Avenue to Franklin Street	Dedicated transit in the median.	1EB 1WB	1EB 1WB	No change
2002.00 1606.00 1605.00	Penrose/Fayette Street Outreach Rosemont Homeowners	Franklin Street from North Franklintown Road to Wheeler Avenue	Dedicated transit in the median that will reduce one lane in each direction.	3EB 3WB	2EB 2WB	-1EB -1WB
1604.00 2001.00	Midtown-Edmondson Penrose/Fayette Street Outreach	Franklin Street Mulberry Street from Wheeler Avenue to Pulaski Street	Eastbound: Dedicated transit on the north side of Mulberry Street.	3EB	2EB	-1EB
		Franklin Street/ Mulberry Street from Wheeler Avenue to Pulaski Street	Westbound: Dedicated transit on the south side of Franklin Street.	3WB	2WB	-1WB
1603.00 1901.00 1802.00	Harlem Park Franklin Square Poppleton	Franklin Street/ Mulberry Street from Pulaski Street to Fulton Avenue	Eastbound: Dedicated transit on north side of Mulberry Street approaching the US 40 “lower level segment.”	2 to 3EB	2 to 1 EB	No Change to 2 EB
			Westbound: Dedicated transit on the south side of Franklin Street continuing from US 40 “lower level segment.”	3 to 2WB	3 to 1WB	-1WB
		US 40 from Fulton Avenue to Carey Street	Dedicated transit in the median. Eastbound travel lanes are reduced by one from Fulton Avenue to Carey Street.	3EB	2EB	-1EB

Table 5: Number of Lanes: 2035 No-Build vs. the Preferred Alternative

Census Tract	Neighborhood	Geographic Limits	Description	2035 No-Build Number of Lanes	2035 Preferred Alt. Number of Lanes	Change
			Westbound total number of lanes remain the same.	3WB	3WB	No Change
		US 40 from Carey Street to N Freemont Avenue	Dedicated transit in the median and the total number of travel lanes remain the same.	3EB 3WB	3EB 3WB	No Change
1802.00 1803.00 0402.00 0401.00 2805.00 0302.00	Poppleton Hollins Market University of Maryland Downtown Jonestown Little Italy	N. Fremont Avenue from US 40 to Martin Luther King Jr. Blvd.	Underground tunnel with no impact on travel lanes.	1EB 1WB	1EB 1WB	No Change
		Lombard Street from MLK Jr. Blvd. to President Street.	Underground tunnel with no impact on travel lanes and parking.	5 to 4 to 2 WB	5 to 4 to 2 WB	No Change
		President Street from Lombard Street to Fleet Street.	Underground tunnel with no impact to travel lanes and parking.	3NB 3SB	3NB 3SB	No Change

Source: Traffic and Parking Technical Report, 2012

7.4 Long-Term Effects on Traffic Volumes and Travel Time

Travel demand forecasts were developed for roadways in the project study corridor. In general, traffic volumes on roadways are projected to be lower under the Preferred Alternative than under the No-Build Alternative in 2035. The Preferred Alternative would decrease traffic volumes on most roadways because some trips would shift from automobile to the Red Line, and because the reduction in the number of lanes with the Preferred Alternative may cause some automobile trips to shift to other roadways. However, the Preferred Alternative would increase average daily traffic volumes in four of the 19 locations analyzed in the project study corridor. Three of those four locations are in EJ areas. **Table 6** presents the three roadway segments where there would be net increases in average daily traffic volumes in EJ areas.

While increases in roadway traffic are projected in three EJ areas under the Preferred Alternative, the amount of the projected increase is small (3 to 4 percent) in two of those areas. The amount is larger in the third area [30 percent, but that increase occurs on an Interstate (I-70), not a residential street]. Additionally, the No-Build Alternative would increase traffic volumes in 12 EJ areas, an even greater number than would be affected under the Preferred Alternative.

Table 6: Average Daily Traffic under the Existing, 2035 No-Build and the Preferred Alternative

Location	Existing (2011) (1)	No-Build (2035) (2)	Percent Growth (1) vs. (2)	Preferred Alt. (3)	Percent Growth (2) vs. (3)
I-70, East of I-695 (Gwynn Oak neighborhood, Census Tract 4011.02)	25,000	34,500	+38%	45,000	+30%
Frederick Avenue west of Hilton Drive (Edmondson Village neighborhood, Census Tract 1608.01)	15,000	17,000	+13%	17,500	+3%
President Street, north of Lombard Street (Downtown neighborhood, Census Tract 0401.00)	35,000	34,500	-1%	36,000	+4%

Source: Traffic and Parking Technical Report, 2012

Decreases in automobile travel time by 50 percent or more are anticipated to occur at nine of the 11 locations analyzed in AM peak hour. Decreases in the AM peak hour occur in the following EJ areas:

- Martin Luther King, Jr. Boulevard between US 40 and Lombard Street (-61 percent in eastbound direction); Poppleton neighborhood (Census Tracts 0402.00, 1803.00 and 1801.00)
- President Street between Pratt Street and Fleet Street (-50 percent in northbound direction); Little Italy neighborhood (Census Tract 0302.00)

An increase in auto travel time by 50 percent or more is expected to occur during the AM peak hour at only one location, President Street between Pratt Street and Fleet Street (+175 percent in southbound direction); Little Italy neighborhood (Census Tract 0302.00). There are no predicted decreases in automobile travel time by in the PM peak hour. However, increases in automobile travel time by 50 percent or more in the PM peak hour are anticipated to occur at three locations within the project study corridor. All of these locations are in EJ areas:

- Parallel Drive from Woodlawn Drive to Ingleside Avenue (+143 percent in westbound direction); Gwynn Oak neighborhood (Census Tract 4011.02). This may be a result of the change in travel patterns along Parallel Drive because of the relocation of the I-70 park-and-ride and the implementation of the Preferred Alternative.
- Franklin Street between Edmondson Avenue and Pulaski Street (+58 percent in westbound direction); Penrose/Fayette Street Outreach, Rosemont Homeowners/Tenants and Mosher neighborhoods (Census Tracts 2001.00, 2002.00, 1605.00, 1606.00)
- President Street between Pratt Street to Fleet Street (+55 percent in westbound direction); Little Italy neighborhood (Census Tract 0302.00)

While impacts to traffic volumes and travel time are experienced in six locations in EJ areas, these impacts would be experienced by all travelers who pass through those areas and not just by residents of the EJ areas. These impacts are the result of providing dedicated travel lanes for the light rail vehicles. In addition, many of the households in the Franklin Street corridor are zero-car households. The light rail service provides a benefit to residents of the EJ areas including zero-car households within the corridor.

7.5 Long-Term Effects on Levels-of-Service (LOS)

Overall, of the 156 signalized and unsignalized intersections identified under the build condition, the Preferred Alternative would reduce the total number of failing intersections compared with the No-Build Alternative. A total of 16 intersections in the AM peak period and 17 intersections in the PM peak period would decrease in LOS in comparison to the No-Build condition. However, 31 intersections in the AM peak period and 20 intersections in the PM peak period would improve under the Preferred Alternative when compared with the No-Build condition. All but 10 of these improved intersections are located in EJ areas; three locations in the AM peak period and seven locations in the PM peak period. Congestion at unsignalized intersections would decrease under the Preferred Alternative, with the exception of the Parallel Drive access point to the SSA parking lot. LOS is generally improved over existing conditions throughout the project study corridor.

The following traffic impacts were considered to be "significant" where:

1. Deterioration in intersection operations from marginally acceptable LOS D to unacceptable LOS E or F, deterioration from LOS E to LOS F, or significant deterioration in vehicle delays within LOS F; or
2. Deterioration in intersection operations from acceptable LOS A or B to LOS D or worse (i.e., a change of at least two levels-of-service when the existing is operating at an optimal level).

Tables 7 and **8** identify intersections which have significant traffic impacts according to the definitions provided above. It is anticipated that most of the intersections that are failing under existing conditions would continue to fail in the future 2035 condition. Under the No-Build Alternative, the LOS would worsen from the existing condition at intersections throughout the entire corridor as a result of traffic volume growth in the region between the years 2011 and 2035. The LOS also would worsen at some intersections under the Preferred Alternative because of traffic volume growth. However, at some locations, the Preferred Alternative would improve LOS because of the decrease in traffic volumes along the project study corridor.

The Preferred Alternative would reduce the total number of failing intersections compared to existing conditions. However, it is anticipated that most of the intersections that are failing in the existing conditions would continue to fail in the future 2035 Build conditions except at the following signalized intersections. The Preferred Alternative is expected to improve the following signalized intersections in EJ areas:

- Security Boulevard and Woodlawn Drive – Census Tract 4011.02 (Gwynn Oak). Improvement from LOS E under Existing Conditions to LOS D under the Preferred Alternative during the PM peak period.

- Security Boulevard and Ingleside Avenue – Census Tract 4013.01 (Gwynn Oak). Improvement from LOS E under Existing Conditions to LOS D under the Preferred Alternative during the AM and PM peak periods.
- Mulberry Street and Pulaski Street – Census Tract 1604.00 (Midtown-Edmondson). Improvement from LOS E under Existing Conditions to LOS C under the Preferred Alternative during the AM peak period.
- Lombard Street and Hopkins Place – Census Tract 0402.00 (University of Maryland). Improvement from LOS F under Existing Conditions to LOS C under the Preferred Alternative during the AM peak period.

Table 7: Peak Hour Levels-of-Service E or F at Signalized Intersections Under Existing Conditions, 2035 No-Build, and the Preferred Alternative

Census Tract	Neighborhood	Signalized Intersections	Existing		No-Build		Preferred Alternative	
			AM	PM	AM	PM	AM	PM
4015.07	Windsor Mill	MD 122 (Security Blvd) at Rolling Road	D	D	D	D	D	**E**
		MD 122 (Security Blvd) at Belmont Avenue	B	D	C	**E**	D	**E**
4011.02	Gwynn Oak	MD 122 (Security Blvd) at Woodlawn Drive	D	**E**	D	**F**	D	D
		MD 122 (Security Blvd) at Ingleside Avenue	**E**	**E**	**E**	**E**	D	D
		Woodlawn Drive at Parallel Drive	C	D	D	D	D	**E**
		Parallel Drive at Ingleside Avenue	B	A	B	C	B	B
4011.01 4013.01	Gwynn Oak	Johnnycake Road at Ingleside Avenue	C	C	**E**	**F**	D	**F**
		US 40 at Ingleside Avenue	D	**E**	D	**F**	D	**F**
2804.01 2804.04	Hunting Ridge Uplands	Edmondson Avenue at Winans Way	C	B	B	A	D	C
		Edmondson Avenue at Swann Avenue	B	B	D	D	B	D
2804.04	Rognel Heights Uplands	Edmondson Avenue at Edmondson Shopping Center	A	A	A	A	B[3]	C[3]
1608.01 2007.01	Edmondson Village Allendale	Edmondson Avenue at Wildwood Parkway	A	B	B	B	D	D
		Edmondson Avenue at Allendale Street	A	B	A	C	C	D
		Edmondson Avenue at Hilton Street	A	B	A	B	D	B
2002.00	Penrose/Fayette St Outreach	US 40 (Franklin St) at Franklintown Road	C	B	B	B	**E**[4]	**E**[4]
2002.00 1605.00	Penrose/Fayette St Outreach Rosemont Homeowners	US 40 (Franklin St) at Warwick Road	B	B	C	C	**E**	C
		Edmondson Avenue at Franklintown Road	C	C	B	C	D[4]	**E**[4]
		Edmondson Avenue at Bentalou Street	B	C	B	B	C	D
1604.00	Midtown-Edmondson	Edmondson Avenue at Payson Street	B	C	C	C	A	A
		Edmondson Avenue at Fulton Avenue	B	B	B	D	B	D
		Mulberry Street at Pulaski Street	**E**	C	B	C	C	C
		Franklin Street at Payson Street	N/A[1]	N/A[1]	C	**F**	D	**E**
		Franklin Street at Monroe Street	B	D	B	D	A	B
1603.00	Harlem Park	Franklin Street at Fulton Avenue	A	C	B	D	A	A

Table 7: Peak Hour Levels-of-Service E or F at Signalized Intersections Under Existing Conditions, 2035 No-Build, and the Preferred Alternative

Census Tract	Neighborhood	Signalized Intersections	Existing		No-Build		Preferred Alternative	
			AM	PM	AM	PM	AM	PM
1703.00	Heritage Crossing	MLK Jr. Boulevard at Franklin Street	D	D	**F**	**F**	**E**	**F**
1801.00	Poppleton	MLK Jr. Boulevard at Mulberry Street	**F**	C	**F**	**F**	**F**	**F**
		MLK Jr. Boulevard at Saratoga Street	**E**	D	**F**	**F**	**F**	**F**
		MLK Jr. Boulevard at Lexington Street	A	A	B	D	B	C
		MLK Jr. Boulevard at Fayette Street	B	B	**F**	**E**	**E**	**E**
		MLK Jr. Boulevard at Baltimore Street	C	**E**	**F**	**F**	**F**	**F**
1803.00	Hollins Market	MLK Jr. Boulevard at Lombard Street	C	**E**	**F**	**F**	D	**F**
0402.00	University of Maryland	Lombard Street at Penn Street	B	**E**	B	**E**	B	**F**
		Lombard Street at Greene Street	C	C	C	**F**	D	**F**
0401.00	Downtown	Lombard Street at Paca Street	B	C	C	**E**	B	D
		Lombard Street at Hopkins Place	**F**	**F**	**F**	**F**	C	**F**
		Lombard Street at Hanover Street	B	**E**	**E**	**E**	B	**E**
		Lombard Street at St. Paul Street/ Light Street	C	**F**	D	**F**	**E**	**F**
		Lombard Street at Calvert Street	C	C	D	**F**	C	**F**
		Lombard Street at South Street	C	C	C	**E**	C	D
		Lombard Street at Commerce Street	A	A	C	B	A	B
		Lombard Street at Market Place	B	B	B	D	C	C
0302.00	Little Italy	Lombard Street at President Street	D	C	**E**	**E**	**E**	**E**
		President Street at Eastern Avenue	C	D	D	**E**	C	**E**
Non-EJ Areas (for comparison purposes)		Fleet Street at Caroline Street	B	B	**E**	**E**	B	C
		Fleet Street at Washington Street	B	C	B	A	A	B
		Boston Street at Aliceanna Street	B	**E**	C	**F**	B	B
		Boston Street at Montford Avenue	B	B	**E**	A	D	A
		Boston Street at Linwood Avenue	A	A	D	B	D	C
		Boston Street at Ellwood Avenue	A	A	A	A	A[3]	D[3]
		Boston Street at Clinton Street	D	C	**F**	C	**E**	D

Table 7: Peak Hour Levels-of-Service E or F at Signalized Intersections Under Existing Conditions, 2035 No-Build, and the Preferred Alternative

Census Tract	Neighborhood	Signalized Intersections	Existing		No-Build		Preferred Alternative	
			AM	PM	AM	PM	AM	PM
		Boston Street at Conkling Street	B	B	**E**	C	**E**	D
		Boston Street at Future Old Boston Street	N/A[2]	N/A[2]	D	C	**E**	**E**
		Conkling Street at O'Donnell Street	D	D	**F**	**F**	**F**	**F**
		O'Donnell Street at New Boston Street (Boh'Donnell Connector)	N/A[2]	N/A[2]	**E**	D	D	D
		O'Donnell Street at Interstate Avenue	C	C	**E**	C	D	C
		O'Donnell Street at I-895 Southbound Ramp	B	B	C	C	B	A
		Bayview Boulevard at Lombard Street	C	C	**E**	**F**	**F**[4]	**F**[4]
		Total – LOS E OR F	**5**	**10**	**19**	**26**	**14**	**25**

Formatting: Red – LOS worsens; **Green** – LOS improves; Black – No change in LOS; **Bold** text – LOS E or F
Notes: [1]Signalized Intersection with LOS D or better; [2]Intersection does not exist in Build conditions
No-Build conditions were compared to Existing conditions. Build conditions were compared to No-Build conditions.
Source: Traffic and Parking Technical Report, 2012

Table 8: Peak Hour Levels-of-Service E or F at Unsignalized Intersections Under Existing Conditions, 2035 No-Build, and the Preferred Alternative

Census Tract	Neighborhood	Unsignalized Intersections	Existing		No-Build		Preferred Alternative	
			AM	PM	AM	PM	AM	PM
4015.07	Windsor Mill	Security Boulevard at Greengage Road	E	D	D	E	B[1]	C[1]
4011.02	Gwynn Oak	Woodlawn Drive at Security Boulevard	B	D	B	E	B	**E**
		Parallel Drive at SSA Access	B	F	C	F	F	**F**
1608.01	Edmondson Village	Edmondson Avenue at Denison Street	F	F	F	F	A[1]	B[1]
2002.00	Penrose/ Fayette St. Outreach	US 40 (Mulberry Street) at Smallwood Street	F	F	F	F	A[1]	B[1]
Non-EJ Areas (for comparison purposes)		Boston Street at Leakin Street	D	F	F	F	F	**F**
		Boston Street at Safeway	B	C	B	D	A[1]	A[1]
		Boston Street at Kenwood Avenue	D	C	F	F	D[1]	D[1]
		Boston Street at East Avenue	A	B	F	D	C[1]	C[1]
		Boston Street at Potomac Street	B	B	D	B	D[1]	C[1]
		Boston Street at Bayliss Street	C	B	F	B	B	B
		Conkling Street at Toone Street	C	C	F	C	F	C
		Bayview Blvd. at Alpha Commons Drive	B	B	F	F	N/A[2]	
		Total – LOS E OR F	3	4	8	8	3	3

Formatting: Red – LOS worsens; Green – LOS improves; Black – No change in LOS; **Bold** text – LOS E or F

Notes: [1]Signalized Intersection with LOS D or better; [2]Intersection does not exist in Build conditions

No-Build conditions were compared to Existing conditions. Build conditions were compared to No-Build conditions.

Source: Traffic and Parking Technical Report, 2012

7.6 Long-Term Effects on Parking

The project would result in an increase in parking spaces in many EJ areas. An additional 1,134 parking spaces would be located at the Security Square Mall, I-70 and Brewers Hill/Canton Crossing park-and-ride lots, which would be constructed as part of the Preferred Alternative. In addition, the planned expansion of park-and-ride lots at the West Baltimore and the Bayview MARC stations are currently programmed and would add another 985 parking spaces. A total 741 parking spaces would be eliminated as part of the Preferred Alternative. Of those 741 spaces, 361 spaces could be accommodated by offsetting parking in adjacent areas.

A total of 551 parking spaces would be eliminated in EJ areas; however 150 of these spaces are located at the SSA West parking lot and a City-owned parking garage at the First Mariner Arena on Lombard Street. Thirty spaces located at the SSA parking lot cannot be accommodated by nearby parking spaces; however, the 120 spaces lost at the First Mariner Arena garage could be accommodated by nearby parking spaces. Of the 401 remaining parking spaces in EJ areas which are located in commercial, industrial or residential zones, 191 parking spaces cannot be accommodated by nearby parking spaces. The areas where the highest number of permanent parking impacts occur are located along US 40/Edmondson Avenue in the Rognel Heights, Edmondson Village, Allendale and the Franklintown Road neighborhoods, (Census Tracts 2804.02, 1608.01 and 1608.02, 2007.01, 2006.00, 1606.00) where 58 spaces would be lost permanently; this total reflects a decrease in parking impacts because 180 impacted parking spaces along US 40/Edmondson Avenue and Franklintown Road, can be accommodated by nearby parking spaces within the corridor. In addition to these effects 105 spaces would be lost along Calverton Road near the OMF site (Penrose/Fayette Street Outreach 2002.00). The total number of spaces that cannot be accommodated by existing parking spaces in EJ areas is 221 parking spaces. The Boston Street corridor was reviewed to determine specific impacts to EJ populations and none were identified. Along Boston Street, 72 parking spaces would be permanently eliminated, and another 54 spaces would be eliminated at local businesses and a City-owned parking lot. The Red Line project team and Baltimore City are working with both communities to identify alternative parking locations.

7.6.1 Truck Loading Zones (TLZs)

TLZs are specialized parking spaces for commercial vehicles making deliveries/pick-up that may be available for loading operations full time or for limited hours of the day. There are no TLZs in EJ areas that would be affected by the Preferred Alternative.

7.6.2 Passenger Loading Zones (PLZs)

PLZs have been designated by the City at the request of public and private businesses that administer services to customers, patients or clients that need ready access. This occurs usually where there is no available on-street or off-street parking in close proximity. Parking is permitted at PLZs for 5 to 15 minutes only to allow for drop-off and/or pick-up of persons visiting the facility. There are no PLZs in EJ areas that would be affected by the Preferred Alternative.

7.7 Long-Term Effects on Public Transit

The project study corridor contains 23 bus routes that either cross or operate parallel to the Preferred Alternative. All of the bus routes traverse EJ areas and serve EJ populations. Four of the top ten bus routes (based on the number of daily riders) in the Baltimore region operate within the project study corridor. Because of the large number of existing bus routes, the majority of the routes in the feeder bus network required to serve the Red Line are already in place.

Overall improved transit connectivity is a major benefit to EJ populations throughout the project study corridor who tend to be more transit-dependent compared with the general population. The headways in the peak period for transit trips from CMS to the Bayview MARC station via the existing transit network would decrease from 10 minutes to 7 minutes and off-peak headways would decrease from 20 or 30 minutes to 10 minutes in year 2035. The public transit improvements would benefit EJ populations.

7.8 Long-Term Effects on Neighborhood Character and Aesthetics in EJ Areas

Impacts on neighborhood character and aesthetics were assessed by determining where the Preferred Alternative would add new elements to or remove existing features from the visual environment and where the options would result in substantial changes to the existing character. The Preferred Alternative contains the following elements that would alter the visual environment: at-grade and aerial transitway alignments; tunnel portals and tunnel ventilation facilities, light rail vehicles; stations; TPSS locations; the OMF; and parking lots. The potential effect on the visual quality of the surrounding environment was rated to determine the range of effect and is discussed below. A summary is presented in **Table 9**. An impact rating of “low,” “medium,” or “high” was assigned to each location based on the following criteria:

- Low impact: does not obstruct the existing viewshed from residential, commercial or institutional properties; not adjacent to primary pedestrian route, public space or platform
- Medium impact: visible from some residential, commercial or institutional properties but is either not on a primary roadway/pedestrian route or is in an area of already compromised visual impact; not adjacent to public space
- High impact: adjacent to residential, commercial or institutional properties; highly visible from primary roadway, retail locations, public space or residences; highly visible from station platform or primary pedestrian route.

Table 9: Summary of Visual Effects in EJ Areas

Census Tract	Neighborhood	Overall Visual Impact Rating	Summary of Contributing Visual Elements
4015.07	Windsor Mill	Low to Medium	Central instrument house (CIH) (medium), Overhead catenary system (OCS) Poles, street fixtures, TPSS-1 (medium), Security Mall Station
4011.01	Gwynn Oak	Medium to High	OCS Poles, Social Security Station, ramps and stairs to station, TPSS-3, CIH, aerial structure over I-695
4013.01	Gwynn Oak	High	Cooks Lane Portal-west, I-70 reconfiguration , park-and-ride lot, TPSS-4, CIH
2804.01	West Hills and Hunting Ridge	Low	Underground tunnel section
2804.01	Hunting Ridge	Low to High	TPSS-5 (high), CIH (high), Cooks Lane Portal-east, OCS Poles, Street fixtures, guideway, Edmondson Avenue Station
2007.01	Allendale	Low	TPSS-6, OCS Poles, Street fixtures, guideway
2002.00	Penrose/Fayette Street Outreach	Medium to High	OMF Facility, OCS Poles, guideway
1603.00 and 1601.00, 0402.00	Harlem Park	Medium to High	TPSS-9 and 10 (high), station platform and entrance structures, guideway, CIH
1801.00, 1803.00, 0401.00	Poppleton, Hollins Market, Downtown	Medium	Station entrances (canopies, escalators and stairs), ancillary structures (ventilation shafts, slurry plants, service rooms etc.)

Source: MTA 2012

7.8.1 West Segment

The Preferred Alternative within the West segment, which is an EJ area, is located primarily within existing roadway right-of-way. TPSS-1 would be located in a landscaped area south of Security Boulevard and north of Winder Road, with a CIH in the median of Security Boulevard. This area, in Census Tract 4015.07 (Windsor Mill), would contain overhead catenary system (OCS) poles along the center of the guideway and street lighting fixtures combined with these poles. Existing landscaping and several trees along this median would be removed and replaced in the median or elsewhere along the project study corridor. The degree of visual change in this area would be low to medium given the existing roadway conditions and replacement of trees.

TPSS-2, located east of Belmont Drive in Census Tract 4015.07, would have visual impacts on residents who live along the south side of Security Boulevard. These viewers would experience impacts to middle-ground and background views from their properties, including the addition of OCS poles, the Security Mall Station and the TPSS. TPSS-2 and guideway would introduce the highest impact to views because of the removal of trees and visibility of the TPSS from the roadway and Security Square Mall and would be considered a medium level of visual impact.

TPSS-3 and a CIH would be located in Census Tract 4011.01 (Gwynn Oak) and adjacent to one another on the north side of the guideway east of this Social Security Administration Station. The guideway and associated OCS poles would be an addition to the foreground and middle-ground views along I-70 and would have a medium impact because they are within the existing highway but there are few existing poles along the highway. The SSA Station would be an addition and would moderately impact views from I-70, Parallel Drive and Woodlawn Drive. The ramp and stairway up to the station would have a high impact because of the removal of existing trees and landscaping. The TPSS, CIH and new roadway connection would also require removal of existing trees, but the visibility of these additions would be low, thus reducing their potential impact.

TPSS-4, a CIH and new roadway connection in Census Tract 4013.01 (Gwynn Oak), would require removal of existing trees, but the visibility of these additions would be low, thus reducing their potential impact. These facilities would impact views for transient viewers as well as some permanent residents. East of Ingleside Drive, the guideway would enter a portal and I-70 would be reconfigured into an at-grade intersection with Security Boulevard and Cooks Lane. The existing highway east of Ingleside would be decommissioned. The degree of change in this area is high because of the reconfiguration of I-70, new roadway construction, and the addition of the park-and-ride lot.

7.8.2 Cooks Lane Tunnel Segment

The Preferred Alternative travels under Cooks Lane to Edmondson Avenue in EJ Census Tracts 2804.01 (West Hills) and 2804.3 (Ten Hills). Only the tunnel portals would be located on the surface; these portals are anticipated to impact the views of residential structures surrounding them.

7.8.3 US 40 Segment

The western portion of the US 40 segment, also an EJ area, would be located along Edmondson Avenue, within existing right-of-way. TPSS-5 would be located on the north side of Edmondson Avenue at Glen Allen Drive in Census Tract 2804.01 (Hunting Ridge) and a CIH would be located at Swann Avenue in Census Tract 2804.02 (Rognel Heights). TPSS-5 would have a high visual impact from primary vehicle and pedestrian routes, is near and visible from residential properties, and is located directly across the street and visible from Hunting Ridge Church.

There would be OCS poles along the center of the guideway and street lighting fixtures would be combined with these poles. The roadway would be reconstructed and existing trees along the median would be removed. The degree of visual change in this area would be medium to high as the station and project components would be easily visible from many residential, commercial and institutional properties. The guideway and OCS poles would be an addition to the foreground and middle-ground views along Edmondson Avenue and would have a low to medium impact because they would be within the existing roadway and would replace existing street light poles, and this segment currently has overhead power wires. The TPSS and CIH structures would be additions to the views and would have a high impact because of the high visibility of the locations by all viewer groups. The station would have a low to medium visual impact because it would be within the existing roadway and would not be replacing trees or landscaping.

Moving eastward, the Preferred Alternative would continue along the center of Edmondson Avenue into Census Tract 2007.01 (Allendale). OCS poles would be located along the center of the guideway; street lighting fixtures would be combined with these poles. The roadway would be reconfigured to accommodate the guideway and the intermittent existing trees along the median would be removed and replaced elsewhere along the corridor. TPSS-6 would be located south of Edmondson Avenue, behind residential properties and along an alley, shielding views from travel lanes. The guideway and OCS poles would be an addition to the foreground and middle-ground views along Edmondson Avenue and would have a medium impact because they would be within the existing roadway and would replace existing street light poles. The TPSS would have a low impact because of limited visibility by most viewers.

TPSS-7 and TPSS-8 would be located in Census Tract 2002.00 (Penrose/Fayette Street Outreach) within the boundaries of the OMF, and, as such, these two TPSS locations would not have a visual impact on the adjacent community in isolation, but rather the impact would be for the entire site. However, the guideway and OCS poles would be an addition to the view and have a low to medium impact because of existing street light and utility poles along the sides of the roadway.

Between the existing MARC rail station and Smallwood Street, there would be an at-grade, split side platform station. There would be one platform adjacent to Franklin Street and one platform adjacent to Mulberry Street. Located east of Monroe Street, TPSS-9 would be located in Census Tract 1603.00 (Harlem Park) between the split guideway in the grass median of US 40. There would be a center platform station at grade with US 40, and between and below the grade of Calhoun Street and Carey Street. The degree of visual change caused by the guideway, station platform and associated project components would be medium because, while visible from US 40, they would be largely hidden from the average upper level viewer. TPSS-10 and a CIH would be located east of Carey Street in Census Tract 1601.00 (Harlem Park). The overall visual impact of the TPSS-9 and TPSS-10, CIH and station entrance structures would be high as they would be visible from primary vehicle and pedestrian routes and are located adjacent to and visible from surrounding residential and commercial properties.

The OMF would be located in Census Tract 2002.00 (Penrose/Fayette Street Outreach). There would be additional OCS poles and wires within this facility, as well as a TPSS, CIH, and parking for workers. Approximately 6.5 million cubic feet of existing buildings would be demolished at the site for the improvements. The addition of a two-story 79,732 square foot building would alter the viewshed within Census Tract 2002.00 (Penrose/Fayette Street Outreach).

Approximately 145,000 square feet of landscaping is anticipated to be needed once the buildings have been built. The proposed OMF and associated systems and structures would have a medium to high visual impact.

7.8.4 Downtown Tunnel Segment

Portions of the Downtown Tunnel segment would be located in EJ areas consisting of Census Tracts 1801.00 (Poppleton), Census Tract 1803.00 (Hollins Market), Census Tracts 0401.00 and 0402.00 (Downtown), and Census Tract 0302.00 (Little Italy). However, the Preferred Alternative would be located entirely underground in these areas with the exception of the station entrances and ancillary structures that would be located at the surface or street level. Station entrance structures would generally be comprised of two escalators and one stair covered by a canopy structure. The ancillary structures would also contain station and tunnel venting equipment and shafts as well as certain service rooms and emergency egress. These structures might be as tall as 60 feet. The guideway and underground stations would not impact views for any of these groups, but the at-grade station entrances and vent shafts would be an addition or modification to views. The overall impact of these structures would be low to medium for the middle three stations, and medium to high for the eastern and western-most stations. In cases where existing buildings are replaced or renovated to accommodate the project facilities, the view would be modified and the overall impact low to medium because of the existing density and context. TPSS-11 and TPSS-12 also are located underground in this segment and would not be visible.

The construction of the portal areas would have additional visual impacts during the anticipated 3 to 5 year construction period.

7.8.5 East Segment

In the East Segment, the alignment would traverse EJ areas in the Highlandtown and Kresson neighborhoods. In this area, the preferred alternative would travel along the west side of Haven Street and along an existing rail right of way and continues up to Pratt Street. There would be one over pass crossing at Eastern Avenue on an existing rail bridge. The alignment would then turn east and cross over an industrial area in the Kreeson neighborhood before continuing across I-895 toward the Bayview Medical Campus. The degree of visual change in most of this area is low due to the industrial context and existing rail right of way. Where there is a bridge structure the degree of change is medium to high because of the potential of longer views of the structure from non-industrial areas. Contextual compatibility is low to medium given the industrial context and existing rail lines

7.9 Long-Term Effects on Community Facilities and Services

Impacts on community facilities and services in EJ areas were assessed by determining if there are property impacts or changes in access or parking that would affect community facilities. Community facilities include park and recreation areas, educational facilities, health care facilities, religious facilities, emergency services, public utilities, transportation facilities, post offices, town halls, and community and recreation centers.

The Preferred Alternative would not displace any community facilities such as schools, libraries, places of worship, emergency services, or park and recreation areas. All major routes providing access to these community services would remain open after the completion of the project. During construction, access to community facilities may be temporarily modified as streets and sidewalks may be closed and traffic re-routed.

The existing corridor contains 23 bus routes that either cross or operate parallel to the Preferred Alternative all traversing EJ areas and serving EJ populations. Four of the top 10 bus routes (based on daily riders) in the Baltimore region operate within the project study corridor. Because of the large number of existing bus routes, the majority of the routes in the feeder bus network required to serve the Red Line are already in place. Long-term impacts to bus service include:

- Majority of the feeder bus service operating in the project study corridor would terminate at a rail transit station, requiring passengers to transfer to light rail or heavy rail service.
- Some existing bus routes parallel to the Preferred Alternative alignment would terminate at a rail transit station, while some local service would continue to operate in order to serve local stops.
- Some routes would operate higher frequencies to encourage transit use and to provide capacity to support the heavier passenger loads anticipated when the Preferred Alternative is implemented.

Detailed route description changes are provided in the *Bus Operations Plan*.

During construction, local area transit would be affected by lane closures and restrictions within the construction corridor. Bus routes would generally be maintained but could be temporarily diverted or relocated to provide reliable service near areas where construction activities would take place. A plan would be developed for relocating bus routes and stops as needed throughout construction. Bus stops could also be temporarily relocated, particularly if the street's right lane is closed for construction.

Increased access and reduced congestion resulting from the Preferred Alternative are anticipated to improve emergency response times overall within the project study corridor. However, delays from gated crossings at the I-70 park-and-ride, Franklin Street, Haven Street, Cassell Drive Crossing, and Bayview Boulevard at Alpha Commons Transitway could increase response times along those routes.

Several local businesses could be affected by temporary changes in access during construction; however, efforts would be made to maintain access during construction.

All major routes providing access to these community services would remain open after completion of the project.

7.10 Long-Term Effects on Air Quality

Potential air quality impacts as a result of the construction of the Preferred Alternative were analyzed at the regional, local, and spot level for the project. The air quality analysis was completed to conform to the requirements of the Clean Air Act of 1990 and the Federal Transportation Conformity Rule along with various Maryland Department of the Environment (MDE) standards. Volatile organic compounds (VOC) and nitrogen oxides (NO_x) were evaluated at the regional level; carbon monoxide (CO), ozone (O_3), particulate matter (PM_{10} and $PM_{2.5}$) and mobile source air toxins (MSAT) were analyzed a the regional and local level.

Regional emissions under the Preferred Alternative are expected to be reduced 1.5 to 1.9 percent in comparison to the No-Build condition for CO, NO_x, VOC, PM_{10} and $PM_{2.5}$. In addition, CO concentrations under the Preferred Alternative would not violate the National Ambient Air Quality Standards. Hot-spot analysis for $PM_{2.5}$ was conducted however; the use of electric powered light rail vehicles would reduce the overall bus trips by 1 percent thus resulting in no CO impacts within the project study corridor and the region at this time. The potential for MSAT effects were analyzed and determined to be lower under the Preferred Alternative compared with the No-Build Alternative because of the implementation of existing emissions control measures and offsets under the build scenario.

Finally, a spot analysis was competed for the OMF (Census Tract 2002.00, Penrose/Fayette Outreach neighborhood). The analysis included the potential air quality effects because of emissions from facility via on-site operations and maintenance. No significant impacts were identified.

7.11 Long-Term Effects on Noise and Vibration

The operational impacts of the Red Line were evaluated using the guidelines set forth by the FTA's Transit Noise and Vibration Assessment and the Federal Highway Administration's (FHWA) Noise Abatement Criteria. Maryland State Highway Administration guidelines were applied to the assessment of noise impacts because of the I-70 realignment and all potential mitigation measures.

7.11.1 Operational Noise

Three noise-and vibration-sensitive land use categories were evaluated for this project and included historic land marks (FTA Category 1), residential (FTA Category 2) and institutional facilities (FTA Category 3). The loudness, or magnitude, of noise determines its intensity and is measured in decibels (dBA) that can range from below 40 dB (e.g., the rustling of leaves) to over 100 dB (e.g., a rock concert). To determine the existing background noise levels at sensitive receptors in the vicinity of the proposed transit rail corridor, noise-monitoring was conducted at 28 representative locations throughout the corridor. The measured day-night noise levels along the project study corridor range from 54 dBA to 79 dBA. Measured peak-hour noise levels at institutional receptors along the project study corridor range from 58 dBA to 69 dBA. Future noise levels under the No-Build Alternative are anticipated to be similar to those under existing conditions. Of the 28 sites analyzed three locations resulted in a *moderate* impact as summarized in **Table 10**.

Table 10: Summary of Noise Impacts

Receptor		Land Use		Noise	Existing	Preferred Alt.[2]	FTA Criteria[1]		Total
ID	**Description**	**Type[3]**	**FTA**	**Metric[4]**	**Noise**	**Noise**	**"Moderate"**	**"Severe"**	**Noise**
M14	W. Franklin St at Franklintown Rd	RES	2	L_{dn}	77	66	65	75	77
M15	W. Mulberry St at Smallwood St	RES	2	L_{dn}	73	65	65	72	74
M26	Boston St at Conklin St	RES	2	L_{dn}	67	63	62	68	69

Notes: 1 FTA criteria include *moderate* and *severe* impact categories

2 *Moderate* impacts under the Preferred Alternative are shaded for clarity.

3 Land use types include single- or multi-family residences (RES), schools (SCH), churches (CHU), medical facilities (MED) and motels (MTL).

4 24-hour day-night noise level, which includes a 10-decibel penalty for all nighttime activity between 10:00 p.m. and 7:00 a.m.

Source: Noise & Vibration Technical Report, 2012.

Noise impacts at the 28 noise monitoring locations were used to characterize noise impacts from the Preferred Alternative at over 1,500 receptors. As a result of this evaluation, corridor-wide project noise exposure levels along the Preferred Alternative are predicted to exceed the FTA *moderate* impact criteria at 96 residences because of LRT warning bells and grade crossing bells. Several exceedances were the result of LRT pass-bys. Ninety-one of the 96 predicted *moderate* exceedances occur in EJ areas and are primarily located on Edmondson Avenue at 23 residences in the Edmondson Village neighborhood and 20 residences in the Allendale neighborhood.

On West Franklin Street in the Mosher neighborhood, 29 residences located across the street from the OMF site are predicted to have *moderate* noise impact because of the combined effects from general maintenance activities and the switches. Noise generated by the OMF site is not expected to result in *severe* impacts at any of the closest receptors in the vicinity of site because any significant activities (such as wheel truing) would occur indoors.

An FTA *severe* impact criteria rating was identified at one residence on Boston Street in the Canton neighborhood, which is not an EJ area. None of the project noise exposure levels are predicted to exceed the FTA *moderate* or *severe* impact criteria at parks, schools or medical buildings along the Preferred Alternative. In addition, no exceedances of the FTA noise impact criteria because of the TPSS facilities are predicted at any receptors along the Preferred Alternative. Additionally, it is anticipated fan plant operations in the future condition would not exceed FTA noise impact criteria. However, impacts from the operation of fan plants would be further analyzed and evaluated during Final Design.

7.11.2 Vibration

The FTA vibration criteria for evaluating ground-borne vibration impacts from train pass-bys at nearby sensitive receptors was used to determine potential impacts. FTA criteria uses three designations to distinguish the intensity of vibration impacts for projects. Frequent events category is defined as more than 70 events per day. Similarly, the occasional events category is defined as between 30 and 70 events per day while the infrequent events category is defined as less than 30 events per day. To describe the human response to vibration, the average vibration amplitude (called the root mean square, or RMS, amplitude) is used to assess impacts. The RMS velocity level is expressed in inches per second or velocity level in decibels (VdB). In general, the vibration threshold of human perceptibility is approximately 65 VdB.

Vibration-monitoring was conducted at 14 representative locations including two medical laboratories throughout the project study corridor. Vibration measurements documented existing vehicular traffic along local streets and arterials in the vicinity the identified receptors. Average vibration levels from existing transportation sources at all sites ranged from 0.01 inches per second (ips) for car pass-bys to 0.05 ips for truck pass-bys. Future vibration levels under the No-Build condition are expected to be similar to those currently experienced under existing conditions. One exceedance was assessed because of LRT pass-by at the location of a hotel adjacent to Security Boulevard.

None of the project noise exposure levels at parks or schools are predicted to exceed the FTA frequent impact criteria along the Preferred Alternative. Corridor-wide vibration levels are predicted to exceed the FTA frequent criterion of 72 VdB at 45 residences. Many of these impacts are because of the proximity of residences to proposed switches. Twenty-seven of the 45 predicted exceedances occur along West Franklin Street (Census Tract 2002.00 Penrose/Fayette Street Outreach neighborhood) across from the OMF site. Ground-borne noise levels are also predicted to exceed the FTA frequent criterion of 35 dBA at 29 residences of the 45 total ground-borne noise exceedance locations in the same area.

Overall, operational noise and vibration impacts would not result in a severe impact in EJ areas under FTA criteria. During Final Design, the MTA would evaluate proposed mitigation measures to determine their effectiveness in reducing noise and vibration impacts.

8. Short-Term Effects During Construction in EJ Areas

This section identifies short-term construction effects during construction of the Preferred Alternative on EJ populations for a total of about four to five years.

8.1 Short-Term Effects on Neighborhoods

One source of impacts on the physical footprint in neighborhoods during construction is the location of proposed construction staging areas. Construction staging areas, also referred to as "laydown areas," are sites that are used for the storage of materials and equipment, and other construction-related activities, such as assembly of concrete forms and reinforcing steel cages. Field offices for contractors and construction managers would be situated in temporary job site trailers at staging areas or existing office space near the construction areas.

Staging areas are typically fenced and are often lit for security. Staging areas of adequate size and proximity to the alignment are essential to minimize construction traffic through the project study corridor and to provide adequate space and access for construction activities. Because of the dense urban environment of Baltimore, very few vacant parcels are available within close proximity to the proposed alignment that could be used for staging areas.

Staging areas in EJ areas include the following locations: Staging area 1-1, 1-4 and 1-6 (Windsor Mill and Gwynn Oak neighborhoods) are within portions of the West segment, and would be located within 20 to 200 feet of several residential homes including single family homes, multi-family residential units and townhouses. Three construction staging areas (3-1, 3-2 and 3-3) would be located along the US 40 segment (Uplands, Penrose/Fayette Street Outreach and Harlem Park neighborhoods) including locations adjacent to residential areas, but are located within the existing roadway. Construction staging areas 3-2 and 3-3 would be below-grade, and would be further buffered by retaining walls and a swath of grass on either side.

Construction staging area 4-1 would be located in the Harlem Park neighborhood and adjacent to existing rowhouses, multi-family residences, and an apartment building. Construction staging areas 4-3, 4-4, 4-5, 4-6 and 4-7 are proposed within census Tract 0401.00 (Inner Harbor) and are surrounded by commercial, retail, and office uses. One residential apartment building is located approximately 50 feet southeast of construction staging area 4-7. Construction staging areas 4-8, 4-9 and 4-10 are not in EJ areas but were analyzed to identify specific impacts to EJ populations. No specific EJ populations were located around construction staging areas 4-3 to 4-10. Construction staging areas are proposed to be located in the public right-of-way or on property purchased for the project through easements or permanent acquisition.

Construction of the downtown tunnel would require the use of a temporary Slurry Plant. This facility would be located within the median of US 40 below Franklin and Mulberry Streets. Although the majority of this facility and related operations would be below grade, some portions of the Slurry Plant would project above street level of Mulberry Street and potentially be visible from Heritage Crossing.

The proposed Poppleton Station would also require the use of a temporary Slurry Plant as part of the station construction activities. It is anticipated that this facility would be located adjacent to the proposed station and that temporary construction barriers would be installed to visually screen the facility from nearby land uses.

8.2 Short-Term Effects from Property Acquisition

Short-term property impacts are assessed by determining if a transportation improvement requires the temporary easement on land outside of existing public right-of-way. There would be temporary easements required to construct the Red Line along various segments of the project, the OMF, tunnel vent facilities, and TPSSs. Temporary property acquisitions or easements corridor-wide total 513,291 sq ft. A total of 236,023 sq ft would be required in EJ areas. The impacts are in various locations throughout the EJ neighborhoods analyzed.

In the Fell's Point neighborhood (Census Tracts 0201.00 and 0203.00), several commercial properties would be displaced in addition to the temporary relocation (for a period of approximately 12 months) of any occupants of several commercial properties along Fleet Street just east of the Broadway intersection. The upper floors of those buildings include apartments that appear to be occupied by residences. It is unknown if those residents constitute an EJ population. However, there is an emerging Hispanic population within the Broadway corridor. Therefore, it is assumed for purposes of this analysis, that the temporary relocations at this location may affect one or more EJ households.

Property acquisition activities, including relocations, will be performed in accordance with the USDOT Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Uniform Act) as amended and FTA Circular 5010.1D, Grants Management Requirements and all applicable Maryland State laws that establish the process through which MTA may acquire real property through a negotiated purchase or through condemnation.

8.3 Short-Term Effects on Traffic Operations

Construction of the Preferred Alternative would result in temporary short-term impacts to local and regional transportation operations including lane closures, temporary signals, temporary roadway closures, detours, and disruption of traffic during peak and nonpeak times.

8.2.1 Lane and Intersection Closures and Turning Movement Restrictions During Construction

Lane closures and turning movement restrictions are anticipated throughout the project study corridor during construction. In addition, the Preferred Alternative would require that minor intersections be closed for approximately two weeks for grade crossing construction. These closures would restrict turning movements from the mainline and turning and through movements on the side streets. Major intersections would not be closed during grade crossing construction because of the potential for major traffic disruption and/or lack of sufficient alternate routes.

For the erection or removal of bridge girders; temporary closures of I-695, Security Boulevard, Janney Street, Kresson Street, CSX Rail, Norfolk-Southern Rail, Oldham Street, Ponca Street, and I-895 would be required. It is anticipated these closures would be of short duration and occur overnight.

8.2.2 Roadway Closures During Construction

Maintenance of traffic options would be limited in areas where open-cut and cut-and-cover activities are undertaken. Cut-and-cover activities would occur at the tunnel portal, station, and ventilation facility areas. Because of limited right-of-way and space requirements for equipment and storage, roadway closures are anticipated at several locations. Additionally, short duration, overnight roadway closures may be required for some construction activities, such as erecting girders.

Roadway closures are expected during construction in the following EJ areas:

- Cooks Lane Tunnel West Portal – Census Tract 2804.01 (West Hills): Construction of the running tunnels by tunnel boring machines and the retained cut structure would require the closure of the loop ramp from southbound Security Boulevard to westbound I-70 throughout the duration of construction. This loop ramp would be ultimately removed in the Preferred Alignment.
- Downtown Tunnel West Portal – Census Tract 1801.00 (Poppleton): Construction of the cut-and-cover tunnel would require the temporary closure of eastbound Mulberry Street for ten (10) to twelve (12) months. Through traffic would be diverted to the US 40 Expressway. Local traffic would be diverted using the local street network. Additionally, construction of the running tunnels by tunnel boring machines and the retained cut structure would require the closure of the entire US 40 Expressway. This closure is anticipated to be in place for approximately three years. Traffic would be diverted to the one-way pair of Mulberry and Franklin Streets. The closure of Mulberry Street and the US 40 Expressway would not occur concurrently.
- Poppleton Station – Census Tract 1801.00 (Poppleton): Construction of the station structure and ancillary building would require the temporary closure of Fremont Avenue between Baltimore Street and Fayette Street. This closure is anticipated to be in place for three to four years. Local traffic would be diverted using the local street network.

There would be additional congestion and delays in areas of roadway closures, including adjacent parallel streets and cross-streets. Access to local businesses through existing or temporary driveways would be provided where possible; however, there may be some instances where access cannot be maintained. In these cases, other accommodations would be arranged with the property owner. Short-term construction impacts are provided in detail in the *Traffic and Parking Technical Report*.

8.2.3 Levels-of-Service During Construction

To understand the impacts of the lane reductions and closures during construction, LOS at key intersections in the project study corridor were calculated for an assumed peak construction year of 2016. Fourteen of the 24 intersections with “failing” LOS along the project study corridor are located in EJ areas. **Table 11** presents the intersections with a LOS E or F under Existing conditions or during the Construction Year in EJ areas.

Table 11: 2016 Construction Year Levels-of-Service

Census Tract	EJ Neighborhood	Signalized Intersections	Existing		Construction (2016) LOS	
			AM	**PM**	**AM**	**PM**
4015.07	Windsor Mill	MD 122 (Security Boulevard) at Woodlawn Drive	D	**E**	C	D
4013.01	Gwynn Oak	MD 122 (Security Boulevard) at Ingleside Avenue	**E**	**E**	D	**E**
4011.01	Gwynn Oak	US 40 at Ingleside Avenue	D	**E**	D	**E**
2804.04	Uplands	US 40 at Swann Avenue	B	B	A	C
1605.00	Rosemont Homeowners/Tenants	Mulberry Street at Pulaski Street	**E**	C	C	C
1801.00	Poppleton	West Mulberry Street at Gilmor Street	C	B	**E**	B
		West Mulberry Street at Carey Street	B	B	**E**	B
		West Mulberry Street at Arlington Street	A	B	**F**	A
		Mulberry Street at Martin Luther King, Jr. Boulevard	**F**	C	**F**	**F**
		Martin Luther King, Jr. Boulevard at Saratoga Street	**E**	D	**F**	**E**
		Martin Luther King, Jr. Boulevard at Baltimore Street	C	**E**	D	**F**
0402.00	University of Maryland	Lombard Street at Martin Luther King, Jr. Boulevard	C	**E**	C	**F**
		Lombard Street at Penn Street	B	**E**	B	D
		Lombard Street at Greene Street	C	C	C	**F**
0401.00	Inner Harbor/Downtown	Lombard Street at Howard Street	C	C	B	**F**
		Lombard Street at Hopkins Place	**F**	**F**	**F**	**F**
		Lombard Street at Hanover Street	B	**E**	B	D
		Lombard Street at Light Street	C	**F**	**F**	**F**
		Lombard Street at Calvert Street	C	C	C	**F**

Table 11: 2016 Construction Year Levels-of-Service

Census Tract	EJ Neighborhood	Signalized Intersections	Existing		Construction (2016) LOS	
			AM	PM	AM	PM
Non-EJ Areas (for comparison purposes)		Boston Street at Aliceanna Street	B	**E**	C	D
		Boston Street at East Street	A[1]	B[1]	B	**E**
		Boston Street at Clinton Street	D	C	D	D
		Eastern Avenue at Patterson Park Avenue	C	C	**F**	**E**
		O'Donnell Street at Conkling Street	D	D	**F**	**E**
		Total – LOS E OR F	**5**	**10**	**9**	**14**

Note: [1]Unsignalized Intersection in worst approach LOS in the Existing condition
Source: Traffic and Parking Impacts Technical Report.

Lombard Street shows the most deterioration in LOS because of the lane closure restrictions associated with the cut-and-cover construction for the station boxes. Short-term effects to traffic operations during construction would be mitigated through the development of maintenance of traffic (MOT) plans during the Final Design and construction phases of the project. Access to major roadways would be maintained where possible. Closures in the cut-and-cover areas have the potential to impact business owners; however, the use of MOT plans would provide access to most businesses. Traffic impacts would affect the entire project study corridor.

8.2.4 Short-Term Effects on Parking

During construction, approximately 2,960 on-street and off-street parking spaces would be temporarily eliminated. A total of 1,022 on-street parking spaces along the Preferred Alternative are required. On-street parking impacts in EJ areas occur on Edmondson Avenue, Franklintown Road, Franklin Street, and Mulberry Street. On-street parking in the proposed station and portal construction areas within the Downtown Tunnel segment (Census Tracts 1801.00, 0401.00, 0402.00) would also be temporarily lost during construction on Fremont Avenue, Light Street, Fleet Street, and Broadway.

A total of 1,938 off-street parking spaces would be removed during construction. Off-street parking zones in EJ areas would also be affected by construction activities. It is possible that some off-street parking spaces adjacent to Security Boulevard would be affected temporarily during construction. A total of 2,318 on-street and off-street parking spaces located in EJ areas would be impacted. Two off-street parking lots and a garage account for a total of 1,567 parking spaces that would be temporarily eliminated at Security Square Mall (293), the Security West facility (386) and a City-owned parking garage located at the First Mariner Arena (888). A large number of on-street and off-street parking spaces are located in commercial and residential areas in EJ neighborhoods:

- Census Tract 4015.07 – Security Boulevard; Boulevard Place Shopping Center (67 parking spaces)
- Census Tracts 2804.01, 2804.02, 2804.03, 2804.04, 2007.01, 2006.00, 1608.01, 2002.00, 1606.00, 1607.00, 1608.02, 2803.01 – Edmondson Avenue from Cooks Lane to Franklintown Road (387 parking spaces)
- Census Tract 2002 (Penrose/Fayette Street Outreach) – Franklin Street from Franklintown Road to Warwick Avenue (50 parking spaces)
- Census Tract 1604 (Midtown-Edmondson) – Edmondson Avenue from Bentalou Street to Fulton Avenue (108 parking spaces)

However, the potential phasing of the project's roadway construction within these areas could reduce the number of lost parking spaces at any given time throughout the project study corridor.

8.4 Short-Term Effects on Transit Services

During construction, local area transit would be affected by lane closures and restrictions within the project study corridor. These disruptions would include: bus stop closures, provision of temporary bus stops to locations as near as possible to existing locations, schedule delays, and bus route detours. Affected transit stops would be temporarily relocated to the nearest possible location on the same transit route without interfering with the adjacent or nearby construction activities. Americans with Disabilities Act (ADA) access and signage for bus stops would be maintained throughout construction. For bus stops maintained in construction areas, pedestrian storage/refuge areas would be provided such that persons waiting for buses are not standing in the road or work area. Information would be provided in advance of and throughout the service disruptions indicating the purpose and duration of the impact.

8.5 Short-Term Effects on Air Quality

An analysis for PM_{10}, $PM_{2.5}$, nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and CO was conducted to determine whether emissions generated by the construction of the Preferred Alternative would significantly impact adjacent land uses at construction sites throughout the project study corridor. Short-term emission estimates were based on peak period activity levels at construction sites throughout the corridor and short-term standards at 1-hour, 8-hour and 24-hour intervals. It was assumed that there would be up to three 8-hour work shifts per day for 30.1 days per month, with emissions being produced every hour for a 24-hour period. Using mitigation techniques to control emissions, the analysis determined that two sites, the Cooks Lane Western Tunnel Portal and the Downtown Tunnel Western Portal would have the highest total emissions because of the duration of construction activities associated with the removal of excavated tunnel materials and transport by truck off-site. Additional analyses were conducted to model conditions and to predict pollutant concentrations. No violations of the NAAQS are predicted at Site 2 or Site 4, therefore there are no violations during construction activity for the project.

8.6 Short-Term Effects on Noise and Vibration

Along the Preferred Alternative, construction activities would include track-laying for aerial and at-grade sections, tunnel/station excavation and blasting, passenger stations, bridges, park-and-ride facilities, and an operations and maintenance facility. Typical distances at which an exceedance of MDE noise limits of 90 dBA at residence during the daytime, 55 dBA at residences during the nighttime and 62 dBA at non-residential receptors is predicted, and ranges from 177 feet to 3,155 feet to 1,409 feet, respectively. These distances to potential impact locations reflect the loudest construction activities including blasting at downtown stations, pile driving and other impact categories associated with station excavation. As a result of these preliminary construction noise estimates, construction activities are predicted to exceed both the MDE daytime and nighttime noise limits. Exceedances of the MDE daytime and nighttime noise L_{max} noise limits are predicted at all 1,538 receptors identified within the project screening distance during daytime and nighttime periods.

Along the Preferred Alternative, construction activities would include the use of bulldozers, dump trucks, vibratory rollers, blasting, and tunnel boring machines (TBM). Blasting and the use of impact pile drivers would be avoided whenever possible to eliminate the potential for vibration impacts (such as minor cosmetic structural damage) at nearby sensitive receptors. The distances at which an exceedance of the FTA vibration damage criterion of 0.5 ips ranges from 8 feet for surface track laying to 30 feet for tunnel boring activities. Construction activities are predicted to exceed the FTA damage criteria at 36 residences from downtown tunneling construction activities. Similarly, above ground or at-grade construction vibration levels are also predicted to exceed the FTA frequent annoyance criteria at 577 receptors from tunneling activities and an additional 230 receptors from surface track laying activities. With mitigation, including the requirement that contractors use noise and vibration control measures, many of the noise and vibration impacts can be minimized.

9. Assessment of Potential for “Disproportionately High And Adverse Effects” On Minority And Low-Income Populations

9.1 Standards for Evaluating Effects

The US Department of Transportation has defined a “disproportionately high and adverse effect” on minority and low-income populations as an adverse effect that:

- “Is predominantly borne by a minority population and/or a low-income population; or
- “Will be suffered by the minority population and/or low-income population and is appreciably more severe or greater in magnitude than the adverse effect that will be suffered by the nonminority population and/or non low-income population.”

The identification of a disproportionately high and adverse effect on EJ populations does not preclude a project from moving forward. USDOT Order 5601.2a states that a project with disproportionately high and adverse effects on EJ populations may be carried out under the following conditions:

- Programs, policies, and activities that would have a disproportionately high and adverse effect on minority populations or low-income populations would only be carried out if further mitigation measures or alternatives that would avoid or reduce the disproportionately high and adverse effects are not practicable. In determining whether a mitigation measure or an alternative is "practicable," the social, economic (including costs) and environmental effects of avoiding or mitigating the adverse effects would be taken into account.
- Programs, policies or activities that would have a disproportionately high and adverse effect on populations protected by Title VI ("protected populations") would only be carried out if:

    (1) A substantial need for the program, policy or activity exists, based on the overall public interest; and

    (2) Alternatives that would have less adverse effects on protected populations (and still satisfy the need identified in subparagraph (1) above) have either:

        (a) adverse social, economic, environmental, or human health impacts that are more severe; or

        (b) would involve increased costs of an extraordinary magnitude.

Determinations of whether a project will have disproportionately high and adverse effects must take into consideration “mitigation and enhancements measures that will be taken and all offsetting benefits to the affected minority and low-income populations…” (USDOT Order, Section 8.b). The FTA Circular explains how benefits are considered in making this determination:

> Determinations of disproportionately high and adverse effects include taking into consideration mitigation and enhancement measures that will be

> incorporated into the project. Additionally, your analysis also should include consideration of offsetting benefits to the affected minority and low-income populations. This is particularly important for public transit projects because they often involve both adverse effects (such as short-term construction impacts, increases in bus traffic, etc.) and positive benefits (such as increased transportation options, improved connectivity, or overall improvement in air quality). Your NEPA EJ analysis will include a review of the totality of the circumstances before you determine whether there will be disproportionately high and adverse effects on EJ populations.
>
> *Source: FTA Circular 4703.1, p. 46.*

9.2 Evaluation of Effects

As described above, the Preferred Alternative has the potential to cause adverse effects on EJ populations, while also benefiting EJ populations. Potential adverse effects on EJ populations in the project study corridor include:

- Business property acquisitions, including some business relocations
- Partial residential property acquisitions (no residential displacements)
- Parking impacts
- Noise and vibration impacts, during construction and operation

However, the Preferred Alternative would greatly improve transit service in Baltimore, creating much faster and more direct transit access from residential neighborhoods in EJ areas to employment and commercial centers in Baltimore City and in Baltimore County. This improvement would benefit low-income and minority areas throughout the project study corridor, including transit-dependent residents of those areas. Some of the EJ areas that would be most directly affected, such as neighborhoods along Edmondson Avenue, would also be among the principal beneficiaries of the project. The Preferred Alternative would increase access to residences and businesses along Edmondson Avenue, helping to promote economic growth.

In addition, while some adverse effects would be borne primarily by EJ populations, the overall effects of the project would be distributed among EJ and non-EJ areas. For example, the surface alignment of the Preferred Alternative along Edmondson Avenue has impacts in EJ areas, however, the primary surface alignment along Boston Street, which is in a non-EJ area, also would have impacts to adjacent development, would reduce the availability of on-street parking during construction and operations, and would reduce the number of traffic lanes on an existing street.

Taking all of these factors into account, FTA and MTA have concluded that the Preferred Alternative, as a whole, would not have “disproportionately high and adverse effects” on EJ populations. Nonetheless, FTA and MTA recognize that some of the specific impacts of the Preferred Alternative may adversely affect EJ populations. Therefore, where possible, the alignment options have been refined through the NEPA process to avoid sensitive areas and minimize impacts to both the human and natural environment. If the Preferred Alternative is approved, minimization efforts would continue in the Final Design and construction phases to reduce impacts in the Red Line station locations. In addition, mitigation efforts have been proposed where applicable and appropriate. Although specific mitigation measures are not required to address impacts to EJ populations as a whole, FTA and MTA have developed commitments to address EJ impacts through ongoing discussion with stakeholders that would provide transparency and assist in the development of environmental commitments to be addressed in the Record of Decision for the project.

10. Full and Fair Access

Full and fair access to meaningful involvement by low-income and minority populations in project planning and development is an important aspect of environmental justice. History has shown that attempting to design major transportation projects without open communication and timely feedback from affected users and communities has caused serious mistakes and expensive delays in the past *(Baltimore Regional Partnership 1999*). Meaningful involvement means the project team invites participation from those groups typically under-represented throughout all the project stages. It is important to advise EJ populations of the project development steps and listen to their feedback. Residents are an important source for local history, special sites, and unusual traffic, pedestrian or employment patterns relevant to the project. This information is used in the design and evaluation of alternatives to avoid negative impacts to valued sites and to support the development of safe, practical, and attractive transportation options that are responsive to the environmental justice population's concerns. The EJ criteria of EO 12898 may be legally satisfied by the timely local outreach.

The full and fair participation by minority and low-income populations in the Red Line decision-making process was achieved by interviewing service providers, city and county agency staff, and community leaders regarding the community's characteristics and their preferred method for receiving information. The information obtained in these meetings provided insight as to how public outreach could be effective and appropriate for EJ populations. Please refer to the *Public Involvement Technical Report,* which contains a detailed description of public involvement activities. A range of tools and techniques have been utilized to engage minority and low-income populations in addition to the general public and they include the following:

10.1 Limited English Proficiency (LEP)

Executive Order 13166 *Improving Access to Services for Persons with Limited English Proficiency* requires federal agencies and funding recipients to develop LEP implementation plans, implement Title VI plan update to include LEP aspects and to continually monitor program effectiveness. At the project level, LEP guidance suggests review of demographic data and engage community groups and organizations in addition to local officials to determine the languages that are spoken in a given area. This information is then used to determine the need for translation services for materials, websites, public meetings and other mediums.

For the Red Line project, bilingual staff attended meetings to provide translation services. The website was also redeveloped to include language translation of web content for more than 25 languages. In addition, project information including newsletters, fact sheets, information sheets, public hearing and meeting notices were also tailored to meet the needs a low-literacy or LEP audiences. Many items were fully translated and were distributed at many Baltimore Red Line outreach events or via the resource hubs and community advocates.

10.2 Hispanic Community Outreach

Press releases, public notices, and LEP documents have been translated, and a Spanish link is available on the project website. MTA has a Spanish translator available at public meetings that are held in the southeastern portion of the project study corridor. Other outreach efforts have included meeting with the Baltimore City Office of Hispanic Affairs, Speaker's Bureau meetings with Spanish speaking communities and organizations, the distribution of project information to "Resource Hubs" in Spanish speaking areas, meeting with the community leader and attendance at events for the Hispanic community including LatinoFest, Cinco de Mayo celebrations, and the Hispanic Heritage Celebration.

10.3 Individual and Community Meetings and Outreach

The Baltimore Red Line "Speaker's Bureau" was created to establish and maintain open communications with residents within the project study corridor and give communities the opportunity to discuss how their community would be affected by the proposed Red Line. These meetings with community associations occur in an informal, small-group setting.

10.4 Citizens' Advisory Council (CAC)

In 2006, the Maryland General Assembly passed a bill creating the Red Line Citizens' Advisory Council (CAC). The bill established the membership of the CAC and its role in the Baltimore Red Line planning process. The CAC is responsible for advising the MTA on impacts, opportunities and community concerns about the Red Line. The CACs:

- advise the MTA on potential neighborhood impacts resulting from the Red Line project;
- provide input to the MTA as the project advances through the planning, engineering, right-of-way acquisition, and construction phases; and
- review economic development opportunities associated with the project.

10.5 Station Area Advisory Committees (SAACs)

The importance of community support, involvement and participation is a cornerstone of the project. Based on these factors, the *Baltimore City Red Line Community Compact* encourages various goals and strategies, and the Station Area Advisory Committees is one of many items that were implemented.

Seventeen SAACs provided input on design issues for the 19 planned stations. The SAACs, which represent communities throughout the corridor, give interested parties an opportunity to participate in MTA's Red Line Station planning process. Since 2010, the SAAC members have participated in regular meetings, every six to eight weeks, and would continue until the end of the station planning process. The SAACs share station design issues with their communities and receive community feedback.

10.6 Community Liaisons

The Community Liaisons play a key role in MTA's efforts to engage the community and enhance awareness of the Red Line project. The Community Liaisons work closely with residents, businesses, community organizations and other stakeholders and serve as contacts between the MTA and community organizations in the study corridor. The Community Liaisons also worked with the SAACs throughout the station design process and acted as an extension of the SAAC facilitation teams. Integrating the Community Liaisons into the Red Line project fulfils one of the goals outlined in the Baltimore City *Red Line Community Compact*. The *Compact* is an agreement among the communities in the Red Line corridor, Baltimore City, the MTA, and other stakeholders to make the Red Line a catalyst for economic and environmental benefits in the project's neighbourhoods. The five Community Liaisons have a vast amount of community outreach experience and as such have spearheaded organizing presentations, community events, business outreach and other outreach efforts throughout the corridor. **Table 12** lists the Community Liaisons and the station areas that they represent.

Table 12: Baltimore Red Line Community Liaisons

Community Liaison	Station Areas Represented
Keisha Trent	CMS Security Square Mall Social Security Administration I-70 Park-and-Ride
Charisse Lue	Edmondson Village Allendale Rosemont West Baltimore MARC
Lisa Akchin	Harlem Park Poppleton Howard Street/University Center Charles Center Government Center/Inner Harbor
Rachel Myrowitz	Inner Harbor East Fell's Point Canton
John Enny	Canton Crossing Highlandtown/Greektown Bayview MARC Bayview Medical Campus

10.7 Public Outreach Events

The Community Liaisons and the Red Line public involvement team participates in various public outreach events to increase awareness of the project throughout the Baltimore region, provide up-to-date project information, as well as create relationships, opportunities, and connections to sustain project outreach and feedback. From 2008 to 2010, the public involvement team and the Community Liaisons have attended more than 200 events and meetings in the corridor the majority have been in EJ areas. During 2011, the public involvement team attended 28 festivals and other summer events including the African American Festival, Canton Farmers' Market Edmondson Village Community Outreach Day, Greater West Hills' Thank You and Community Fellowship Day, Patterson Park Harvest Festival and Lantern Parade, West Baltimore MARC Farmers' Market, and the Woodlawn Farmers' Market.

10.8 Other Outreach Activities

Other outreach activities, many of which have taken place in EJ neighborhoods, have been on-going since Spring of 2003. These activities include:

- Public Meetings – scoping meetings, open houses, and community workshops
- Community Working Group Meetings
- Project information distribution at Resource Hubs
- Coordination with Elected Officials
- Red Line Website
- Publications – Including Print advertisements, newsletters, fact sheets, fliers, door hangers, and rack cards.

Since the AA/DEIS was issued, the Red Line project has continued to conduct an intensive public involvement effort to address concerns and mitigate potential effects. Please refer to the *Public Involvement Technical Report* in Appendix I of the FEIS, which contains a detailed description of public involvement activities that occurred between November 2008 and June 2012. The 2008 *Red Line Public Involvement Technical Report* describes the outreach activities prior to November 2008.

11. References

Baltimore City, 2012. Baltimore's Neighborhoods Statistical Areas Map (with 2010 Census Tracts).

Baltimore County Planning Department.

Federal Transit Administration. 2012. FTA Circular 4703.1 *Environmental Justice Policy Guidance for Federal transit Administration Recipients*

Federal Highway Administration. 1998. *FHWA Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (6640.23).

Maryland Transit Administration (MTA). 2012. *Alignments Technical Report*.

MTA. 2012. *Neighborhood Effects Technical Report*.

MTA. 2012. *Noise & Vibration Technical Report*.

MTA. 2012. *Public Involvement Technical Report*.

MTA. 2012. *Red Line Construction Issues – Avoidance, Minimization and Mitigation*.

MTA. 2012. *Traffic and Parking Technical Report*.

MTA. 2012. *Property Requirements Technical Report*.

United States Census Bureau Website. 2012. Fact Finder. *United States Census 2010*. http://factfinder.census.gov

United States Council on Environmental Quality. December 1997. *Environmental Justice Guidance Under the National Environmental Policy Act*.

United States Department of Housing and Urban Development. 2006 – 07. *Enviromapper*. http://egis.hud.gov/egis/

United States Department of Transportation. 2012. *Final DOT Environmental Justice Order* (5610.2(a))

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION

MARYLAND TRANSIT ADMINISTRATION

Baltimore, Maryland

Baltimore Red Line

Red Line General Engineering Consultant

Indirect and Cumulative Effects Analysis Technical Report

December 2012

Document No.
1734

Table of Contents

1. Introduction and Methodology

An indirect and cumulative effects analysis was completed to assess the potential indirect (secondary) and cumulative (incremental) effects of the Red Line when combined with other past, present, and reasonably foreseeable future actions in the vicinity of the project study corridor. This technical memorandum also includes discussion of appropriate mitigation measures, where appropriate.

1.1 Purpose of the Project

The Red Line project is just one step in the ongoing development of an interconnected regional transit system that would improve the quality of transit service in the Baltimore Region. The purpose of the Red Line project is to provide the following improvements in the project study corridor, which extends from the Centers for Medicare & Medicaid Services (CMS) in Baltimore County to the Johns Hopkins Bayview Medical Center campus in Baltimore City:

- Improve transit efficiency by reducing travel times for transit trips in the corridor
- Increase transit accessibility in the corridor by providing improved transit access to major employment and activity centers
- Provide transportation choices for east-west commuters in the corridor by making transit a more attractive option
- Enhance connections among existing transit routes in the corridor
- Support community revitalization and economic development opportunities in the corridor
- Help the region improve air quality by increasing transit use and promoting environmental stewardship

In order to provide an accurate assessment of the indirect and cumulative effects on resources as a result of the implementation of the Red Line, it is important to identify the regional context in which the project is located. The project spans through portions of Baltimore County and Baltimore City and is primarily located in highly urban, developed areas. Nineteen stations have been located throughout the project study corridor, five of which are located in the Downtown Tunnel segment.

1.2 Preferred Alternative

The Red Line Preferred Alternative is a 14.1-mile light rail transit line that would operate from the CMS in Baltimore County to the Johns Hopkins Bayview Medical Center campus in Baltimore City (**Figure 1**). The transitway includes a combination of surface, tunnel, and aerial segments. The alignment, stations, park-and-ride facilities, system elements, tunnel ventilation, light rail vehicles, operations and maintenance facility, and rail and bus operations plans are described in this section.

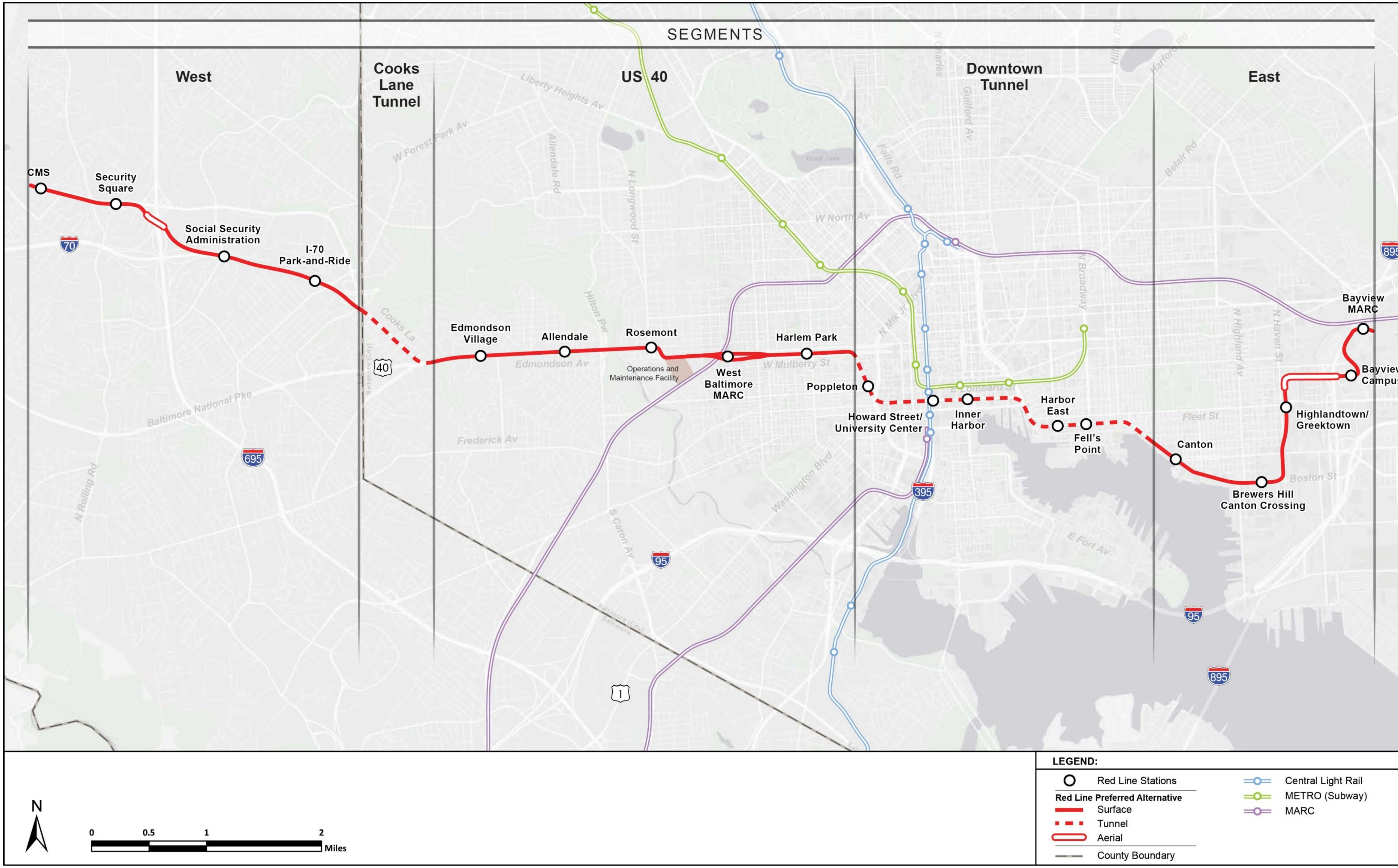


Figure 1: Red Line Preferred Alternative Segments

For analysis purposes, the project study corridor has been divided into five segments consisting of three at-grade/aerial segments and two tunnel segments totaling approximately 14.1 miles (**Figure 1**). From west to east, these segments are: (1) West, (2) Cooks Lane Tunnel, (3) US 40, (4) Downtown Tunnel, and (5) East.

1.2.1 West Segment (2.9 miles)

The west segment begins in Baltimore County at the CMS Station, a center-platform station, located west of Rolling Road on the south side of Security Boulevard. At the western end of the Preferred Alternative, 380 feet of tail track would be provided beyond the station for the purpose of operation flexibility. The Preferred Alternative would continue east in an exclusive right-of-way adjacent to the south side of Security Boulevard. The Preferred Alternative would continue east with at-grade crossings at Greengage Road, Brookdale Road, Boulevard Place Shopping Center entrance, and Rolling Road. From Rolling Road, the Preferred Alternative would run adjacent and parallel to the south side of Security Boulevard and along the northern boundary of Security Square Mall crossing Lord Baltimore Drive at grade. The Preferred Alternative would continue to the center platform Security Square Station located immediately west of Belmont Avenue. A park-and-ride lot is proposed at this station and at full development would have 325-375 parking spaces.

The Preferred Alternative would extend east across Belmont Avenue at grade to the west side of I-695 (Baltimore Beltway), continuing southeast and crossing the interchange diagonally on an aerial structure over I-695. The Preferred Alternative would continue adjacent to the existing parking lots at the Social Security Administration (SSA) west campus and along the north side of the I-70 ramp to I-695. The Preferred Alternative would continue east transitioning onto the existing excess pavement of westbound I-70, just west of Woodlawn Drive, to the center platform SSA Station just east of Woodlawn Drive.

Continuing east, the Preferred Alternative would cross at grade with a roadway connection from I-70 to Parallel Drive and continues on the former roadway pavement to the I-70 Park-and-Ride Station. The station and park-and-ride facility are located west of Ingleside Avenue occupying the on-ramps to the former westbound I-70. Initially, the I-70 Park-and-Ride lot would have 650-700 parking spaces with the opportunity for expansion in the future.

Continuing east of the I-70 Park-and-Ride Station, the Preferred Alternative would cross over Ingleside Avenue on an existing bridge and curves in a southeast direction to the tunnel portal for the Cooks Lane Tunnel segment.

1.2.2 Cooks Lane Tunnel Segment (1.3 miles)

The Preferred Alternative surface alignment would transition to a 734-foot portal section in the southwest quadrant of the existing cloverleaf interchange at the end of I-70. This existing interchange loop ramp would be removed as part of the project. This tunnel section would begin through the portal on the northwest side of the intersection of Cooks Lane/Forest Park Avenue/Security Boulevard. The tunnel alignment would continue southeast under the intersection in a twin-bore tunnel beneath Cooks Lane crossing into Baltimore City. The tunnel would continue southeast centered under Cooks Lane to north of Coleherne Road; then curve left towards Edmondson Avenue and continues east following the centerline of Edmondson Avenue. The tunnel would continue along the centerline of Edmondson Avenue ascending through a portal section to meet grade approximately 400 feet west of Swann Avenue.

1.2.3 US 40 Segment (3.3 miles)

The US 40 segment would begin after the tunnel portal, continuing east in an exclusive right-of-way along the median of Edmondson Avenue crossing Swann Avenue at grade to the Edmondson Village Station. This center-platform station is located mid-block between Swann Avenue and North Athol Avenue.

The Preferred Alternative would continue east in the median of US 40 with at-grade crossings at traffic signal-controlled intersections at North Athol Avenue, Wildwood Parkway, and North Louden Avenue to the Allendale Station at the intersection of US 40 and Allendale Street. The Allendale Station would have a split platform with the westbound platform located on the west side of Allendale Street and the eastbound platform located on the east side of the intersection. The Preferred Alternative would continue east at grade across Denison Street and Hilton Street. The Preferred Alternative would cross over the Hilton Parkway and Gwynns Falls in the center of an existing bridge. Baltimore City is currently developing plans to replace the existing Edmondson Avenue Bridge designed to include accommodations for the Red Line.

The Preferred Alternative would continue east at grade through the Edmondson Avenue (US 40)/Franklin Street intersection and Poplar Grove Streets. The Rosemont Station platform would be located in the center of Edmondson Avenue east of Poplar Grove Street. East of the Rosemont Station, the Preferred Alternative would turn right and traverse south along the center of Franklintown Road. At the intersection of Franklintown Road and Franklin Street, the Preferred Alternative would turn left and continue east along the median of US 40/Franklin Street. This is also the proposed location for the Operations and Maintenance Facility (OMF) site on the south side of Franklin Street. Following the existing roadway, the Preferred Alternative would split near Wheeler Avenue and continue east diverging to cross under the Amtrak Northeast Corridor. The Preferred Alternative would maintain the existing structures over West Franklin Street and West Mulberry Street with minor modifications to the bridge structures, roadway, and utilities to protect the structures. The eastbound track would be adjacent to the north side of Mulberry Street, crossing under the existing Amtrak bridge to the West Baltimore MARC Station eastbound platform located at the northwest corner of Smallwood Street and Mulberry Street. The West Baltimore MARC Station westbound platform is located at the southwest corner of Smallwood Street and Franklin Street. The westbound track is adjacent to the south side of Franklin Street. The split tracks would continue east along the edge of the West Baltimore MARC parking lots with separate at-grade crossings of Pulaski Street and Payson Street. The tracks diverge from Franklin and Mulberry Streets and rejoin just west of the North Fulton Avenue Bridge.

The Preferred Alternative would continue east in the median of the existing US 40 lower level roadway corridor. The Preferred Alternative tracks would split east of the Stricker Street pedestrian bridge onto the eastbound left lane of the US 40 corridor. The Harlem Park Station, a center platform station, would be located between Calhoun Street and Carey Street. East of

Carey Street the tracks would merge back to double-track before passing under the existing pedestrian bridge at Carrollton Avenue. The Preferred Alternative would continue under the Arlington Avenue Bridge to the portal for the Downtown Tunnel.

1.2.4 Downtown Tunnel (3.4 miles)

The tunnel would begin in the median of US 40 immediately west of the North Schroeder Street Bridge and would continue east descending into a 1,200-foot tunnel portal within the median of US 40. The tunnel would then curve underneath Mulberry Street and continue south, beneath Fremont Avenue to the proposed underground Poppleton Station located immediately north of Baltimore Street. The entrance to the underground Poppleton Station would be located at the northeast corner of the intersection of Fremont Avenue and Baltimore Street.

The tunnel alignment would continue south and curves east crossing underneath Martin Luther King, Jr. Boulevard to the center of Lombard Street. The tunnel would continue east beneath Lombard Street to the underground Howard Street/University Center Station, located immediately east of Howard Street. The entrance to the underground station would be located at the northeast corner of Howard and Lombard Streets. The Preferred Alternative would cross under the existing CSX railroad tunnel beneath Howard Street just west of the proposed station.

The tunnel alignment would continue east to the underground Inner Harbor Station located underneath Lombard Street between Light and Calvert Streets. The entrance to the station would be located at the northeast corner of Lombard and Light Streets and along the north side of Lombard Street west of Calvert Street. From this station there would also be a pedestrian tunnel underneath Light Street to provide a direct connection to the Charles Street Metro Station located underneath Baltimore Street.

The Downtown Tunnel alignment would continue underneath Lombard Street until Market Place where the alignment curves south centered underneath President Street to Fleet Street. The tunnel alignment would then turns east, underneath Fleet Street to the underground Harbor East Station located east of Central Avenue.

The alignment would continue east centered underneath Fleet Street to the underground Fell's Point Station on the west side of Broadway. The entrance to the station would be located in the median of Broadway north of Fleet Street.

The tunnel alignment would continue east underneath Fleet Street to Washington Street and would turn southeast under Chester Street to Boston Street. The tunnel would continue southeast underneath Boston Street to a tunnel portal east of the intersection with Montford Avenue/Hudson Street ascending to the median of Boston Street at surface.

1.2.5 East Segment (3.2 miles)

The Preferred Alternative would continue southeast at grade in the median of Boston Street to the Canton Station. The Canton Station would be a center platform station located west of the signalized intersection at South Lakewood Avenue.

Boston Street would be developed as one lane in each direction from Montford Avenue to Conkling Street. The Preferred Alternative would continue along the center of Boston Street with at-grade crossings at the signalized intersections of South Lakewood Avenue, South Kenwood Street, Potomac Street (pedestrians only), South East Street, South Clinton Street, and South Conkling Street to the Brewers Hill/Canton Crossing Station. This center platform station would be located between South Conkling and South Eaton Streets and includes a park-and-ride lot with approximately 500-600 parking spaces.

The Preferred Alternative would continue east, at grade across Eaton Street and would transition diagonally on new right-of-way turning north on the west side of Haven Street. The Preferred Alternative would continue north adjacent to the west side of Haven Street crossing under the O'Donnell Street Bridge into the Canton Railroad right-of-way. The Preferred Alternative would then turn northeast crossing South Haven Street at grade into the Norfolk Southern (NS) right-of-way. The Preferred Alternative would continue north within the NS right-of-way to the Greektown/Highlandtown Station, a side platform station, which would be located south of Old Eastern Avenue. The Preferred Alternative would occupy the western portion of the NS right-of-way, a currently inactive railroad right-of-way, referred to as Bear Creek Branch.

The Preferred Alternative would continue north over Eastern Avenue on the existing freight railroad bridge and then ascend and turn east onto a new aerial structure, passing overhead of the NS right-of-way. The structure would cross above Janney Street, Kresson Street, CSX railroad, NS railroad, Oldham Street, Ponca Street, and I-895 to the Johns Hopkins Bayview Medical Center campus property. The alignment would continue east at grade along the alignment of Alpha Commons Drive to the Bayview Campus Station. This center platform station would be located immediately west of Bayview Boulevard. The Preferred Alternative would turn north at grade on the east side of Bayview Boulevard continuing north adjacent to Bayview Boulevard with at-grade crossings of Nathan Shock Drive, a National Institutes of Health (NIH) driveway, and Lombard Street. The Preferred Alternative would continue north turning northeast along the eastside of I-895 to the proposed Bayview MARC Station, the eastern terminus of the Preferred Alternative. A park-and-ride lot with approximately 650 parking spaces is proposed as part of a new Bayview MARC Station, which is separate project to be implemented by the Maryland Transit Administration (MTA) and Baltimore City. At the eastern end of the alignment, 380 feet of tail track would be provided beyond the station for the purpose of operational flexibility.

1.2.6 Stations and Station Facilities

The Preferred Alternative would include 19 stations, 14 surface and five underground, to provide access and connections to the light rail service. The proposed Red Line station locations have been identified based upon compatibility with surrounding site conditions, intended passenger catchment areas, site circulation, site services and amenities, transit oriented development opportunities, public space availability, future urban plan visioning, community input through the Station Area Advisory Committees (SAACs), and other public outreach (refer to Chapter 8 of the Final Environmental Impact Statement (FEIS) for additional information concerning Public Involvement).

Stations are proposed at the following locations:

- CMS Station
- Security Square Station
- Social Security Administration Station
- I-70 Park-and-Ride Station
- Edmondson Village Station
- Allendale Station
- Rosemont Station
- West Baltimore MARC Station
- Harlem Park Station
- Poppleton Station
- Howard Street/University Center Station
- Inner Harbor Station
- Harbor East Station
- Fell's Point Station
- Canton Station
- Brewers Hill/Canton Crossing Station
- Highlandtown/Greektown Station
- Bayview Campus Station
- Bayview MARC Station

1.2.7 Operations and Maintenance Facility

The OMF is where light rail cars would be stored, maintained, and dispatched on their daily routes each day. The OMF would accommodate administrative and light rail operation functions for the Red Line. The site, as currently proposed, would be comprised of 11 existing parcels totaling 20.8 acres in Baltimore City. The OMF would be located along the south side of US 40/Franklin Street centered around Calverton Road between Franklintown Road and Warwick Avenue, and referred to as the Calverton Road site. Currently, these parcels support light industrial uses and would be compatible with the use as the OMF.

At the Calverton Road site, the Red Line OMF would be comprised of three main buildings, light rail track into and out of the facility site, three CIHs, and two TPSS for the mainline and the site, and a covered fuel station. There would be an area for employee and visitor parking totaling approximately 200 spaces, and the site would be secured and fenced.

The overall storage and maintenance facility site as currently programmed would include approximately 77,000 square feet of parking, 12,000 square feet of exterior support spaces, 62,700 square feet of light rail vehicle storage, and 251,000 square feet of lead tracks.

1.2.9 Traction Power Substations

To provide electricity along the line for the light rail vehicles, 17 TPSSs are proposed and would be located along the alignment. The TPSS require approximately 45-foot by 85-foot sites plus access roads or driveways. A typical TPSS would be constructed of steel housing and depending on the location, could be surrounded by fencing, a brick wall, landscaping, or other forms of aesthetic barriers. The TPSS would be spaced along the alignment, approximately one mile apart. Two TPSS locations would be within underground stations and one location would be within the proposed OMF. Preliminary locations for TPSS sites have been identified for analysis in the FEIS document and supporting technical reports. Final substation locations would be determined during Final Design for the project.

1.3 Indirect and Cumulative Effects Analysis Methodology

The Council on Environmental Quality (CEQ) regulations set forth in 40 CFR § 1500 et. Seq., require federal agencies to also consider the potential for indirect and cumulative effects from a proposed project. The resources evaluated for indirect and cumulative effects resulting from the Red Line include those socioeconomic, cultural and natural resources directly impacted by the project.

1.3.9 Regulatory Requirements

The CEQ regulations set forth in 40 CFR § 1500 et. Seq., require federal agencies to also consider the potential for indirect and cumulative effects from a proposed project. The CEQ regulations define the impacts and effects that must be addressed and considered to meet the National Environmental Policy Act (NEPA) requirements, as follows:

- Direct effects are caused by the action and occur at the same time and place (40 CFR § 1508.8(a))
- Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems (40 CFR § 1508.8(b)).
- Cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR § 1508.7).

The terms “effects” and “impacts” are considered synonymous, as used in the CEQ regulations.

1.3.10 Methodology

The indirect and cumulative effects analysis was completed using available information on past, present and foreseeable future development, as well as readily available data from published plans and studies. Information was obtained from the Baltimore City Planning Department, Baltimore County Department of Planning, and the Baltimore Development Corporation.

The resources evaluated for indirect and cumulative effects resulting from the Preferred Alternative include those socioeconomic, cultural, and natural resources directly affected by the project.

A combination of analysis methodologies were employed to assess indirect and cumulative effects. The analyses were based on readily available information and data including:

- Trend Analysis: historic data were collected to understand past events and patterns, as well as the rates at which effects occurred
- Map Overlays: mapping layers were compiled to create a reasonable and foreseeable future land use scenario

The indirect and cumulative effects analysis included the identification of resources of interest and establishment of the geographic boundary and temporal boundary (time frame) for which the analysis was conducted. Analysis included determination of past, present and reasonably foreseeable future projects and analysis of indirect and cumulative effects to resources of interest within the defined temporal and geographic boundaries.

a. Resources of Interest

Any resource or component of the physical, natural, or social environment that is directly affected by the Preferred Alternative is included in the indirect and cumulative effects analysis. **Table 1** lists the resources evaluated for this indirect and cumulative effects analysis, along with the boundary within which they would be analyzed. As part of the indirect and cumulative effects analysis, all direct effects of the Preferred Alternative are evaluated. Potential indirect and cumulative effects would be assessed within the overall indirect and cumulative effects analysis boundary by either the subwatershed area in which they are located or by the station area they are located closest to. Station areas were chosen as representative areas where development could occur. The subwatersheds were chosen to represent the environment within which the natural resources could be potentially affected by the project.

Table 1: Indirect and Cumulative Effects Analysis Resources and Geographic Boundaries

Resource	Representative Sub-Boundary
Land Use	Subwatersheds
Transit Oriented Development	Subwatersheds
Air Quality, Greenhouse Gases, and Climate Change	Subwatersheds
Floodplains	Subwatersheds
Forests	Subwatersheds

Table 1: Indirect and Cumulative Effects Analysis Resources and Geographic Boundaries

Resource	Representative Sub-Boundary
Land Use	Subwatersheds
Transit Oriented Development	Subwatersheds
Community Facilities and Services	Station Area
Demographics and Environmental Justice	Station Area / US Census Tracts
Economic Conditions	Station Area / US Census Tracts
Public Parks and Recreational Facilities	Station Area
Cultural Resources (Built Historic Properties and Archeological Sites)	Station Area
Noise and Vibration	Station Area
Street Trees	Station Area
Hazardous Materials	Station Area
Utilities	Station Area

b. Geographic Boundary

The indirect and cumulative effects analysis geographic boundary was developed using the boundaries of environmental resources, traffic analysis zones and socioeconomic units that would be directly and indirectly impacted by the Red Line project. Those areas traversed by the Red Line Preferred Alternative alignment were synthesized to create the overall indirect and cumulative effects analysis geographic boundary (see **Figure 2**). They include:

- 2010 US Census tracts
- Baltimore Metropolitan Council (BMC) Traffic Analysis Zones (TAZs)
- Sub-watersheds (as defined by the Maryland Department of Natural Resources)

The indirect and cumulative effects analysis boundary encompasses approximately 64 percent of Baltimore City, as well as a small portion of eastern Baltimore County (between US 40 and MD 150), a portion of Western Baltimore County (adjacent to Baltimore City surrounding both sides of I-695 between I-795 and US 40), and a very small portion of northern Anne Arundel County. The majority of the indirect and cumulative effects analysis geographic boundary is comprised of the following subwatersheds:

- Back River
- Jones Falls
- Baltimore Harbor
- Middle Gwynns Falls
- Lower Gwynns Falls

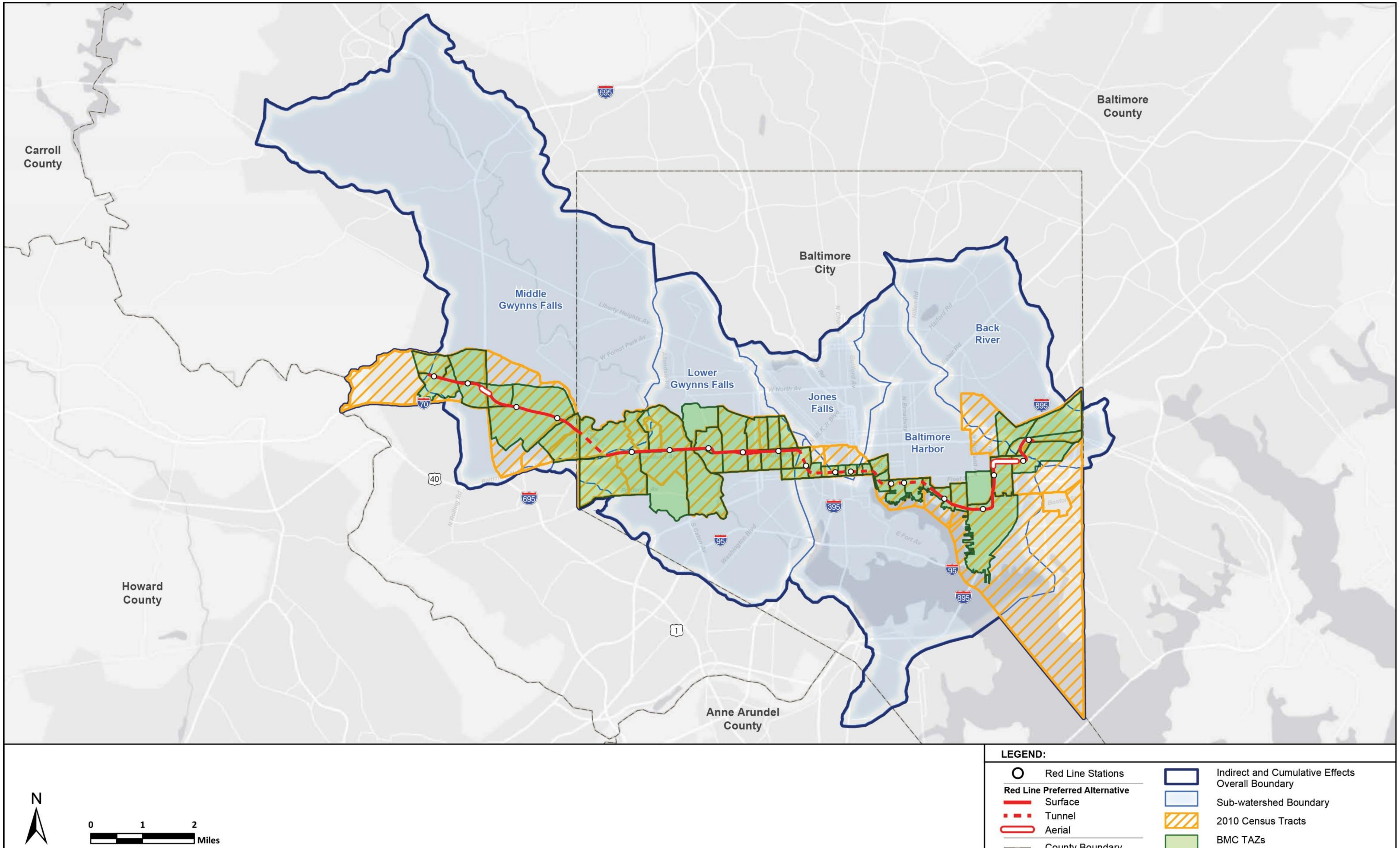


Figure 2: Indirect and Cumulative Effects Boundary

c. Temporal Boundary

The indirect effects analysis assesses the impact the proposed project would have on resources directly affected by the action during the present and into the foreseeable future (2012-2035).

The cumulative effects analysis assesses the impacts the proposed project would have when combined with other past, present, and reasonably foreseeable future actions. The time frame established begins in 1950 and extends to 2035.

The past time frame was selected based upon available Census data, historic events, development trends, and population changes. In 1969 the eastern most segment of I-70 was constructed. The opening of this segment of the I-70 national highway was a significant transportation event that had a major influence on the region's land use and growth patterns. I-70 was envisioned to provide a link from Baltimore County in the west through downtown Baltimore, but because of opposition from environmental groups and local residents, the project was terminated. Often referred to as I-170, the "highway to nowhere" or "the ditch", this portion is under-utilized as it provides no connection to the east.

Between 1970 and 2010 the population of Baltimore City decreased by approximately 31 percent, while the population of Baltimore County increased by approximately 30 percent (see **Table 2**). In general, American cities experienced a decline in the middle part of the 21st Century as suburban populations grew, automobile ownership increased and the growing highway transportation network expanded. In response, the urban renewal movement began to gain momentum nationwide in the 1960s and 1970s. One major catalyst to this movement in Baltimore City is known as Charles Center. Constructed in 1962, this 23-story modern office tower skyscraper is seen as a fundamental step in the urban renewal movement. During the 1970s efforts to redevelop and revitalize the downtown and Inner Harbor areas were underway. A new urban retail and restaurant complex, Harborplace, opened in 1980, followed by major tourist attractions including the National Aquarium and the Baltimore Museum of Industry. This steady growth in the Inner Harbor area continued to spread to adjacent neighborhoods and continues today along the Red Line project study corridor.

Table 2: Regional Population Trends, 1970 to 2010

Year	Baltimore City	Baltimore County
1970	905,759	621,077
1980	786,775	655,615
1990	736,014	692,134
2000	651,154	754,292
2010	620,961	805,029
% change, 1970 - 2010	-31.4%	29.6%

Source: Maryland Department of Planning, November 2010

The future time frame (defined here as 2020 to 2035) was chosen because it encompasses the period of time that the proposed action's impacts would persist beyond the project life. The year 2035 was selected as the horizon year because existing regional plans and projections have been forecasted up to that point in time. Actions intended for a time beyond 2035 are not considered reasonably foreseeable. Therefore, the overall temporal boundary for the indirect and cumulative effects analysis extends from 1970 to 2035.

Baltimore City and Baltimore County are both expected to experience a steady increase in population growth between 2012 and 2035 (see **Table 3**). However, the trends indicate that much of the growth within the indirect and cumulative effects analysis boundary would occur in the form of redevelopment, as opposed to new construction requiring significant changes in land use designations. Redevelopment resulting in higher densities may occur in some areas, particularly where transit oriented development (TOD) is anticipated, as discussed in Section E.2. Because of the developed nature of the indirect and cumulative effects analysis boundary, significant changes in land use caused by development are not anticipated.

Table 3: Regional Population Projections, 2020-2040

Year	Baltimore City	Baltimore County
2020	670,950	847,000
2030	682,950	862,200
2040	690,950	868,000
% change, 2020 - 2040	3.0%	2.5%

Source: Maryland Department of Planning, November 2010

2. Past, Present and Reasonably Foreseeable Future Projects

2.1 Past Projects

Several significant historic events shaped the development of Baltimore between the 1950s and today. After World War II suburbanization began to spread and residents migrated from the City into the surrounding counties. By the 1950s between 7,000 and 8,000 houses a year were being constructed in the counties and as population migrated out of the City, retail and industry followed. In the 1950s and 1960s many residential areas in the City were demolished to make way for new expressways, schools, and public housing projects. During this time, the City as a whole and in particular the Edmondson Village area, experienced a notable shift in the composition of home owners as white residents were replaced by African-Americans. During this period home values decreased. Another significant development that was completed in 1962 is One Charles Center. As the first modern office tower to be constructed in Baltimore, it was considered a success and a catalyst for continued office, hotel, residential, and retail developments in the area. The success of Charles Center enabled continued investment in the renovation of downtown Baltimore. Using Federal Urban Renewal Funds, the City constructed new infrastructure of piers, bulkheads, roads, utilities, and parks along the waterfront. In the 1980s and 1990s development continued with Harborplace, the National Aquarium, Power Plant, the Gallery, the Maryland Science Center, and the new Baltimore Visitors Center.

Significant transportation projects that were completed during the several decades prior to the initiation of the Red Line are listed below. These projects are considered significant because they, in part, have laid the foundation for the need to expand east-west transit in the Red Line project study corridor.

Highway Projects

- 1955-1962: Opened segments of the I-695 beltway around Baltimore City
- 1969: Easternmost segment of I-70 opened
- 1971: I-95 between the Baltimore Beltway and the Washington DC Capital Beltway completed

Transit Projects

- 1965: Baltimore Area Mass Transportation Plan, framed future rail transit system
- 1983: “Section A” of Metro line opened, from Charles Center to Reisterstown Plaza
- 1987: “Section B” of Metro Line opened, from Reisterstown Plaza to Owings Mills
- 1992: North-South Light Rail Line opened for service connecting Timonium to Glen Burnie
- 1994: “Section C” of Metro Line opened, from Charles Center to Johns Hopkins Hospital
- 1997: Light Rail extended to Hunt Valley, BWI Airport and Penn Station

- 2002: Baltimore Region Rail System Plan adopted, identified Red Line as one of three priority corridors

2.2 Present Projects

Planned improvements and development within the Red Line project study corridor was used to qualitatively analyze the cumulative effects on changes to the community and surrounding environment. Planned improvements within the indirect and cumulative effects analysis boundary were considered as part of this analysis, including:

- Ongoing development of regional transit service
- Planned roadway improvements (regional and local)
- Planned bicycle and pedestrian improvements

These present and near-future improvements have all been considered in the planning of the proposed project. The MTA has coordinated closely with Federal, State, and local resource agencies, area institutions, and private landowners and developers in designing a transit system that can be seamlessly incorporated into the existing and future environment.

Funded transportation improvement projects (transit, regional highway, local, and bicycle/pedestrian) that are currently underway within the Baltimore City and Baltimore County portions of the indirect and cumulative effects analysis boundary area are summarized in **Table 4** and are shown on **Figure 3**.

Table 4: Present Transportation Improvements

Facility	Location	Subwatershed	Description
Transit Projects			
Intermodal Bus Center	Russell Street	Baltimore Harbor	New bus facilities
Transit Vehicle Purchase	Extending from the Baltimore Visitor's Center to the Fort McHenry National Monument and Historic Shrine	Baltimore Harbor	Fleet improvement
MTA- Bus	Statewide	All subwatersheds	Fleet Improvement
MTA- Bus and Rail Improvements	Statewide	All subwatersheds	Preservation and improvements to bus, light rail, Metro facilities, MTA offices, and park-and-ride lots
MTA- Transit	Statewide	All subwatersheds	Preservation and improvements to Light Rail fleet
I-695: Bridge at MD 26	MD 26 and I-695 (Liberty Road)	Middle Gwynns Falls	Bridge repair/deck replacement

Table 4: Present Transportation Improvements

Facility	Location	Subwatershed	Description
Baltimore and Potomac Tunnel	Baltimore	Lower Gwynns Falls, Jones Falls	New tunnel alignment to augment and replace the existing B&P Tunnel
Regional Highway Projects			
Areawide Enhancement Projects	Statewide	All subwatersheds	Includes: pedestrian/bicycle facilities; scenic easements and historic sites; scenic/historic highway programs; landscaping/ beautification; historic preservation; rehabilitation/ operation of historic transportation facilities; preservation of abandoned railway corridors; archeological planning/research; and mitigation of water pollution because of highway runoff.
I-95, JFK Hwy (Section 100)	I-895 to north of MD 43	Outside boundary area	Add two Express Toll Lanes in each direction, upgrade interchanges at I-895, I-695, and MD 43
Local Projects in the Indirect and Cumulative Effects Analysis Boundary			
US 40, Baltimore National Pike	Edmondson Avenue Bridge	Lower Gwynns Falls	Widen from two to four lanes
Various Bridge replacements	Old Court Road Bridge #237 over Bens Run, Piney Grove Road Bridge #140	Middle Gwynns Falls; Middle Gwynns Falls	Bridge repair/deck replacement
Edmondson Avenue Bridge	Over Gwynns Falls/CSX Railroad	Lower Gwynns Falls	Bridge Widening from eight to 10 lanes to accommodate dual track light rail
Boston Street Realignment	Between Boston Street and O'Donnell Street	Baltimore Harbor	New, extended roadway
Citywide Street and Urban Reconstruction	North Avenue streetscape, West Baltimore MARC neighborhood improvements, etc.	Baltimore Harbor, Jones Falls, Lower Gwynns Falls	Road resurfacing/reconstruction
Sisson Street Bridge over CSX	Sisson Street between 24th and 26th Streets	Jones Falls	Sisson Street Bridge over CSX

Table 4: Present Transportation Improvements

Facility	Location	Subwatershed	Description
Broening Highway Reconstruction	Broening Highway between Holabird Avenue and Colgate Creek	Baltimore Harbor	Resurfacing
Key Highway / Light Street Roundabout	Construction of a 2-lane roundabout at the intersection of Key Highway and Light Street	Baltimore Harbor	Road reconstruction / Roundabout
Frederick Avenue Bridge	Over the Gwynn Falls and the CSX railroad tracks	Lower Gwynns Falls	Bridge repair/deck replacement
Annapolis Road and Waterview Bridges Over BW Pkwy	Replacement of deteriorated bridges over Baltimore Washington Parkway	Lower Gwynns Falls	Bridge repair/deck replacement
Park Circle Roundabout	Intersection at Reisterstown Road and Druid Park Drive	Lower Gwynns Falls	Road reconstruction
Citywide Earmarks and Enhancements	Citywide	All subwatersheds	To improve and enhance transportation facilities throughout Baltimore City
Dogwood Road Bridge #72	Over Dogwood Run	Outside Boundary Area	Bridge repair/deck replacement
Gwynnbrook Avenue Bridge #202	Over Gwynns Falls	Outside Boundary Area	Bridge repair/deck replacement
Dogwood Road Bridge #347	Over Dogwood Run	Outside Boundary Area	Bridge repair/deck replacement
Old Ingleside Avenue Bridge	Bridge #96 over Dead Run	Middle Gwynns Falls	Bridge repair/deck replacement
Old Court Road Bridge #237	Over Bens Run	Outside Boundary Area	Bridge repair/deck replacement
Milford Mill Road Bridge #76	Over Gwynns Falls	Middle Gwynns Falls	Bridge repair/deck replacement
Rolling Road Bridge	Bridge #358 over Branch of Dead Run	Middle Gwynns Falls	Bridge repair/deck replacement
Ingleside Avenue Bridge	Bridge # 97 over Dead Run and Dogwood Road	Middle Gwynns Falls	Bridge repair/deck replacement
Biennial Bridge Inspection	Countywide inspection of all bridges as federally mandated.	All subwatersheds	Bridge inspections
I-695 Bridge over MD 26 Liberty Road	I-695 at MD 26	Middle Gwynns Falls	Rebuild I-695 bridge over MD 26

Table 4: Present Transportation Improvements

Facility	Location	Subwatershed	Description
Owings Mills Boulevard	Winands Road to Lyons Mill Road	Middle Gwynns Falls	New four-lane road
Rolling Road	Windsor Mill Road to MD 26	Middle Gwynns Falls	Widen from two to four lanes
Owings Mills Boulevard	Winands Road to MD 26	Middle Gwynns Falls	New two lane road
Bicycle/Pedestrian Projects			
Kent Street Transit Plaza	Kent Street between Annapolis Road and the Westport Light Rail Station	Baltimore Harbor	Bicycle/pedestrian facility improvements to transit connections and safety
Baltimore City Tour Bus Parking Facility	West Pratt Street and South Arlington Avenue	Lower Gwynns Falls	Construct a new tour bus parking facility
Reconnecting West Baltimore	West Baltimore between Harlem Park and University of Maryland	Baltimore Harbor, Jones Falls, Lower Gwynns Falls	Pedestrian and bicycle network connecting major parks and employment centers in West Baltimore
Areawide Recreational Trails Program	Statewide	All subwatersheds	Redesign, reconstruction, non-routine maintenance, or relocation of recreational trails to benefit the natural environment
Herring Run- Southern Extension	Sinclair Lane to Bayview Medical Center	Back River	Existing and proposed "Rail with Trail"
Jones Falls Greenway Phases IV and V	Woodberry Light Rail Station to Clyburn Arboretum	Lower Gwynns Falls (portion)	Continuation of trail
Jones Falls Trail	Penn Station to Maryland Science Center	Baltimore Harbor, Jones Falls	Construct phase 2

Source: Baltimore Region Transportation Improvement Program 2012-2015

Major development projects that are currently planned or underway within the Red Line project study corridor are summarized by segment.

2.2.1 West Segment

Development plans within the West segment include the sub-division of four small residential lots, resulting in nine additional dwelling units and the following new construction of a warehouse, hotel/motel, 16-unit apartment building, two 121,000 square-foot office buildings and three office buildings ranging from 18,000 to 36,000 square feet.

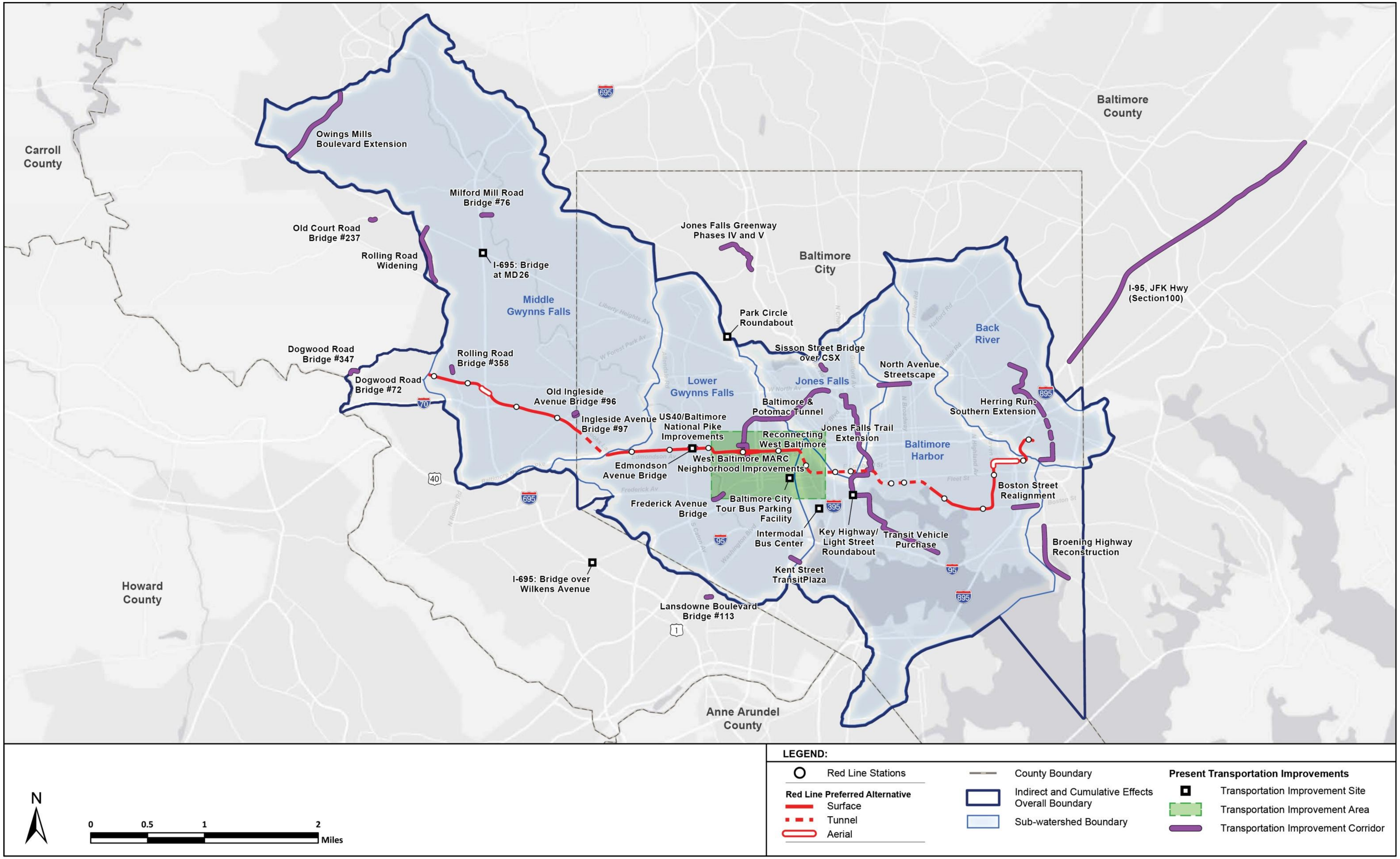


Figure 3: Present Transportation Improvements

2.2.2 Cooks Lane Tunnel Segment

There are no development projects under construction, approved, or planned within the Cooks Lane Tunnel segment.

2.2.3 US 40 Segment

The US 40 segment contains one significant development project which is currently under construction. When complete, the Uplands residential development would occupy 100 acres and contain 1,100 mixed income dwelling units.

2.2.4 Downtown Tunnel Segment

The Downtown Tunnel segment contains several development projects. Beginning in the west, near the Poppleton Station, there are two development projects: one 22,000 square-foot residential complex and a 200,000 square-foot University of Maryland cancer treatment center. Farther east there are plans to construct a multi-use development with 1,800-dwelling units and 100,000 square feet of retail space. Plans to construct a 200,000 square-foot commercial lab and office building for the University of Maryland have been submitted for approval.

In downtown Baltimore, near the Inner Harbor Station, there are five approved projects that are currently on hold: three hotel projects (ranging from 150 rooms to 300 rooms); one 100-unit hotel/residential project; and a mixed-use redevelopment of the former Mechanic Theater containing a 120,000 square-foot hotel, 100,000 square-foot of retail, and a residential component.

In the Harbor East Station area, there is an approved 1.8-million square-foot office and retail complex that would be proceeding in phases. In the Fell's Point Station area near the Broadway Market there is an approved 155-dwelling-unit project approved. Approved, but on hold, is a 92,700-square foot, 130 room Aloft Hotel, a 735-dwelling unit residential project, and a mixed-use 284-dwelling unit and 13,000-square foot retail project. Also near the Fell's Point Station, the Union Wharf residential complex is under construction. The development contains 280 dwelling units and is expected to be completed by 2014. Also near the Fell's Point Station, there is a 100-unit apartment project planned.

2.2.5 East Segment

Within the East segment there are several proposed development projects. Adjacent to the Brewers Hill/Canton Crossing Station, there is a large mixed-use development project that is ongoing. The Brewers Hill project is expected to be a total of 1.9 million square feet and include 430-dwelling units, 600,000 square feet of retail space, and 650,000 square feet of office space.

Also near the Brewers Hill/Canton Crossing Station there are three approved projects. One project would have 440 apartments and between 5,000 and 19,000 square feet of retail space. Another is a 480,000 square-foot mixed-use shopping center, and the third project is a 700 space parking garage.

East of the Highlandtown/Greektown Station is a 17.9-acre residential development site. Approximately 4.5 acres of the site are partially built. Near the Bayview Station, the National Institute of Health is constructing 5-million square feet of new office space.

2.3 Reasonably Foreseeable Future Projects

The Baltimore City and Baltimore County Comprehensive Master Plans provide general goals and objectives for growth in the communities. Objectives for the Baltimore City Master Plan include strengthening neighborhoods and elevating the quality of the built environment.

The Baltimore County Master Plan designated the Woodlawn-Security area as an employment center where industrial and office development is concentrated. The County ensures that the redevelopment of the County's employment centers would contribute to the stability of the surrounding communities by supporting the Security/Woodlawn Business Association's efforts to strengthen the area as a business location.

Reasonably foreseeable future transportation projects within the indirect and cumulative effects analysis boundary have been gathered from the long range planning document, *Plan It 2035*, adopted by the Baltimore Metropolitan Council in November 2011. *Plan It 2035* was developed with local, state, and federal transportation agencies, area business leaders, community advocates and other stakeholders. The projects within or directly adjacent to the indirect and cumulative effects analysis boundary are summarized in **Table 5** and shown on **Figure 4**.

Table 5: Reasonably Foreseeable Transportation Improvements

Facility	Location	Subwatersheds	Description
Transit Projects			
Bayview MARC and Intermodal Station	Lombard Street at Bayview Boulevard	Back River	New Station to connect with Red Line
MARC Camden Line	MARC Growth and Investment Plan Improvements	Baltimore Harbor, Lower Gwynns Falls	Capital Investment through 2020
MTA Green Line	Johns Hopkins Hospital to North Avenue	Back River, Baltimore Harbor	Extension of Metro
MARC Growth and Investment (2016-2025 and 2016-2035)	West Baltimore, Odenton, Martin State and others	Baltimore Harbor, Jones Falls, Lower Gwynns Falls	Improvements to capacity, maintenance facilities and station areas
Red Line	Baltimore City and County– Woodlawn to Bayview	All subwatersheds	New light rail line
Regional Highway Projects			
I-95, JFK Hwy (Section 100)	I-895 to north of MD 43	Outside Boundary Area	Add two Express Toll Lanes in each direction, upgrade interchanges at I-895, I-695, and MD 43
I-695	MD 122 to I-95 South	Middle Gwynns Falls (portion)	Widen from six to eight lanes
Local Projects in the Indirect and Cumulative Effects Analysis Boundary			
Broening Highway	Reconstruct Colgate Creek Bridge	Baltimore Harbor	Provide direct access for trucks to port

Table 5: Reasonably Foreseeable Transportation Improvements

Facility	Location	Subwatersheds	Description
Canton Truck Bypass	Clinton Street to Haven Street	Baltimore Harbor	New two lane roadway to accommodate truck traffic from port
New Vail Street	Keith Avenue to Chesapeake Commerce Center	Baltimore Harbor	New two lane roadway to accommodate truck traffic from port
Security Boulevard	Existing terminus to Fairbrook Road	Middle Gwynns Falls (portion)	New two lane roadway
I-695	Bridge over Milford Mill Road	Middle Gwynns Falls	Bridge reconstruction
Roundabout	North Avenue and Harford Road	Baltimore Harbor	Construction of roundabout
Bicycle/Pedestrian Projects			
Haven Street Trail (Red Line Rail with Trail)	Highlandtown to Canton Waterfront Park	Baltimore Harbor	Multimodal trail
Martin Luther King, Jr. Boulevard Side Path	Jones Falls Trail at Maryland Avenue to Gwynns Falls Trail sidewalk at ramp to Russell Street	Jones Falls, Lower Gwynns Falls	Rehabilitation/widening of existing sidepath
Red Line Trail	Baltimore City to Red Line terminus in County	All subwatersheds	Off-road trail linking City and County major employment destinations
Herring Run- Southern Extension	Sinclair Lane to Bayview Medical Center	Back River	Existing and proposed “Rail with Trail”
Bicycle/Pedestrian Access to Rail Stations	Throughout Baltimore City and Baltimore County	All subwatersheds (portion)	Improve bicycle/pedestrian access to rail transit stations (safety, ADA access, etc.)

Source: Baltimore Regional Transportation Board “Plan It 2035”

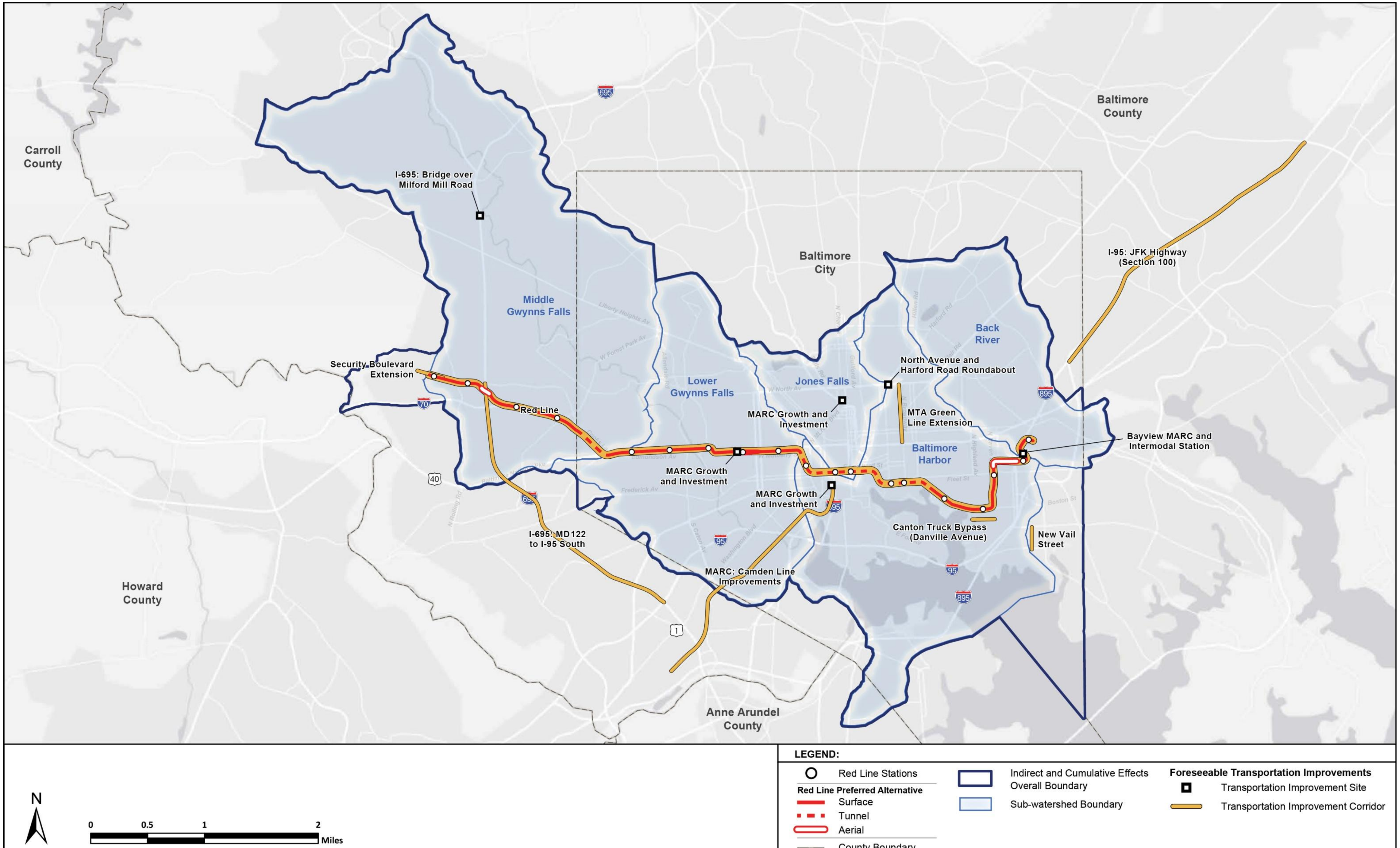


Figure 4: Foreseeable Transportation Improvements

3. Affected Environment

Existing conditions are described by the subwatershed or station area within which they are located (as shown in **Table 1**). Detailed descriptions of the subwatersheds and station areas within the overall indirect and cumulative effects analysis boundary are provided below.

3.1 Description of Subwatershed Areas Included in Cumulative Effects Analysis

There are five subwatersheds included in the indirect and cumulative effects analysis boundary (see **Figure 2**).

3.1.9 Back River Subwatershed

The Back River subwatershed portion of the indirect and cumulative effects analysis boundary is located in the eastern part of Baltimore City and has a small portion located in eastern Baltimore County. Based on Maryland Department of Planning (MDP) 2002 GIS land use data, the Baltimore County portion of the Lower Back River subwatershed portion of the indirect and cumulative effects analysis boundary has 326.5 acres of land. The land acres are divided as follows:

- Urban: 5,067.6 acres (88.7 percent)
- Agriculture: 6.9 acres (< 1 percent)
- Forest: 424.5 acres (7.4 percent)
- Wetlands: 0 acres (0 percent)
- Barren land: 73 acres (<1 percent)

The Baltimore City portion of the Back River subwatershed portion of the indirect and cumulative effects analysis boundary has 67.8 acres of open water and 5,714.6 acres of land. The Baltimore City land acres are divided as follows:

- Urban: 10,803 acres (93 percent)
- Agriculture: 6.9 acres (< 1 percent)
- Forest: 768 acres (7 percent)
- Wetlands: 0 acres (0 percent)
- Barren Land: 562.7 acres (9.8 percent)

The upper part of Back River subwatershed is within the Piedmont Plateau Physiographic Province, while the remaining majority is within the Coastal Plain Physiographic Province. The general topography is characterized by gentle to steep rolling topography and low hills and ridges.

Land use within the subwatershed is predominantly high- and medium-density residential and industrial. Historic land use trends for the Back River subwatershed are shown in **Table 6**. Current land use is shown in **Table 7**.

Table 6: Back River Subwatershed Historic Land Use

Land Use	1973 (ac)	2002 (ac)	% Change
Total Developed Residential	2,569.4	2,414.6	-6.0%
Total Developed Non-Residential	2,019.6	2,477.3	22.7%
Total Developed	4,588.9	4,891.9	6.6%
Total Resource Lands	1,175.7	1,081.3	-8.0%

Table 7: Back River Subwatershed Current Land Use

Land Use	2002 (ac)	2010 (ac)	% Change
Low-Density Residential	0.0	2.8	100.0%
Medium-Density Residential	1,080.0	949.4	-12.1%
High-Density Residential	1,334.6	1,446.6	8.4%
Commercial	797.4	416.1	-47.8%
Industrial	747.2	1,161.8	55.5%
Institutional	776.8	741.1	-4.6%
Open Urban Land	562.7	533.9	-5.1%
Forest	429.8	455.7	6.0%

3.1.10 Jones Falls Subwatershed

The Jones Falls subwatershed portion of the indirect and cumulative effects analysis boundary is located in central Baltimore City. Based on MDP 2002 GIS land use data, the Jones Falls subwatershed portion of the indirect and cumulative effects analysis boundary has 48.1 acres of open water and 2,729.1 acres of land. The land acres are divided as follows:

- Urban: 2,293.4 acres (69 percent)
- Agriculture: 0 acres (0 percent)
- Forest: 37.7 acres (1.4 percent)
- Wetlands: 0 acres (0 percent)
- Barren land: 267.7 acres (9.6 percent)

This subwatershed is located within the Piedmont Plateau and Coastal Plain Physiographic Provinces and is characterized by gentle to steep rolling topography and low hills and ridges. Surface elevations range from sea level (at the Chesapeake Bay) to 680 feet above sea level. Streams in the Piedmont are incised and follow rock fractures and weathered rock while stream channels in the Coastal Plain are broader. The majority of soils in the subwatershed have moderately well to well drained soils or a layer impeding downward water flow (MDE, 2002e). The 100-acre Lake Roland impoundment is located along Jones Falls. Other tributaries of this impoundment are Roland Run and Towson Run. Land use in this subwatershed is predominantly high-density residential and commercial.

Historic land use trends for the Jones Falls subwatershed are shown in **Table 8**. Current land use is shown in **Table 9**.

Table 8: Jones Falls Subwatershed Historic Land Use

Land Use	1973 (ac)	2002 (ac)	% Change
Total Developed Residential	1,359.9	1,138.6	-16.3%
Total Developed Non-Residential	1,088.5	1,285.2	18.1%
Total Developed	2,448.4	2,423.7	-1.0%
Total Resource Lands	275.5	305.4	10.8%

Table 9: Jones Falls Subwatershed Current Land Use

Land Use	2002 (ac)	2010 (ac)	% Change
Low-Density Residential	0.0	0.0	0.0%
Medium-Density Residential	1.2	1.2	0.0%
High-Density Residential	1,137.4	1,176.4	3.4%
Commercial	713.9	672.3	-5.8%
Industrial	89.4	80.7	-9.8%
Institutional	351.5	328.0	-6.7%
Open Urban Land	267.7	286.8	7.1%
Forest	37.7	37.5	-0.4%

3.1.11 Baltimore Harbor Subwatershed

The Baltimore Harbor subwatershed portion of the indirect and cumulative effects analysis boundary is located in central and southeastern Baltimore City and has a small portion within northern Anne Arundel County. Based on MDP 2002 GIS land use data, the Anne Arundel County portion of the Baltimore Harbor subwatershed has 329.2 acres of land. The land acres are divided as follows:

- Urban: 267.6 acres (81.3 percent)
- Agriculture: 0 acres (0 percent)
- Forest: 0 acres (0 percent)
- Wetlands: 0 acres (0 percent)
- Barren land: 61.6 acres (18.7 percent)

The Baltimore City portion of the Baltimore Harbor subwatershed has 3,313.9 acres of open water and 12,746 acres of land. The Baltimore City land acres are divided as follows:

- Urban: 8,478.3 acres (66.4 percent)
- Agriculture: 113.3 acres (< 1 percent)
- Forest: 12.5 acres (< 1 percent)
- Wetlands: 12.1 acres (< 1percent)
- Barren land: 612.7 acres (4.8percent)

The majority of this subwatershed is located within the Coastal Plain Physiographic Province with two smaller portions located in the Piedmont Plateau Physiographic Province. The subwatershed also includes numerous small tributaries to the north side of the Patapsco River that drain to tidal estuaries. Many streams in the industrial area have been channelized and the natural drainage pattern has been altered (e.g., cooling water for Bethlehem Steel is withdrawn from Jones Creek and discharged to Bear Creek). It is estimated that 60 percent of the freshwater in the harbor originates from Patapsco River. Smaller tributaries feeding the Harbor are the Gwynns Falls, Jones Falls, Bear Creek, and Curtis Creek.

The Harbor estuary is highly developed with urban residential, commercial, and industrial land uses. Land use in this subwatershed is predominantly high-density residential and industrial. Historic land use trends for the Baltimore Harbor subwatershed are shown in **Table 10**. Current land use is shown in **Table 11**.

Table 10: Baltimore Harbor Subwatershed Historic Land Use

Land Use	1973 (ac)	2002 (ac)	% Change
Total Developed Residential	3,702.7	3,343.1	-9.7%
Total Developed Non-Residential	4,765.9	5,352.2	12.3%
Total Developed	8,468.6	8,695.3	2.7%
Total Resource Lands	754.0	835.9	-3.3%

Table 11: Baltimore Harbor Subwatershed Current Land Use

Land Use	2002 (ac)	2010 (ac)	% Change
Low-Density Residential	0.0	8.1	100.0%
Medium-Density Residential	290.7	238.5	-18.0%
High-Density Residential	3.273.4	3,336.4	1.9%
Commercial	739.5	800.8	7.4%
Industrial	3,357.4	3,253.0	-3.1%
Institutional	1,038.3	983.4	-5.1%
Open Urban Land	580.5	687.9	10.2%
Forest	12.5	17.6	41.1%

3.1.12 Lower Gwynns Falls Subwatershed

The Lower Gwynns Falls subwatershed portion of the indirect and cumulative effects analysis boundary is located in western Baltimore City and extends slightly into Baltimore County. Based on MDP 2002 GIS land use data, the Baltimore County portion of the Lower Gwynns Falls subwatershed portion of the indirect and cumulative effects analysis boundary has 208.2 acres. The land acres are divided as follows:

- Urban: 195.3 acres (93.8 percent)
- Agriculture: 6.9 acres (<1 percent)
- Forest: 0.1 acre (<1 percent)
- Wetlands: 0 acres (0 percent)
- Barren land: 0 acres (0 percent)

The Baltimore City portion of the Lower Gwynns Falls subwatershed has 6,984.3 acres of open water and 14,287.5 acres of land. The Baltimore City land acres are divided as follows:

- Urban: 10,633.1 acres (50 percent)
- Agriculture: 96.8 acres (< 1 percent)
- Forest: 1,383.8 acres (6.5 percent)
- Wetlands: 0 acres (0 percent)
- Barren land: 1,209.3 acres (5.7 percent)

The majority of this subwatershed is located within the Piedmont Plateau Physiographic Province while the lower portion is located in the Coastal Plain Physiographic Province. The subwatershed roughly follows the southern portion of the Gwynns Falls drainage basin through western Baltimore City. Land use in this subwatershed is predominantly residential, forest, and industrial.

Historic and current land use trends for the Middle and Lower Gwynns Falls subwatersheds are shown in **Tables 12 – 15.**

Table 12: Lower Gwynns Falls Subwatershed Historic Land Use

Land Use	1973	2002	% Change
Total Developed Residential	5,628.5	4,808.2	-14.6%
Total Developed Non-Residential	2,511.1	3,497.1	39.3%
Total Developed	8,139.6	8,305.4	2.0%
Total Resource Lands	1,663.8	1,498.1	-10.0%

Table 13: Lower Gwynns Falls Subwatershed Current Land Use

Land Use	2002	2010	% Change
Low-Density Residential	0.0	2.2	100.0%
Medium-Density Residential	1,168.6	1,154.9	-1.2%
High-Density Residential	3,639.6	3,667.5	0.8%
Commercial	896.0	736.8	-17.8%
Industrial	1,161.2	1,291.7	11.2%
Institutional	990.4	986.6	-0.4%
Open Urban Land	904.9	954.7	5.5%
Forest	582.1	581.4	-0.1%

3.1.13 Middle Gwynns Falls Subwatershed

The Middle Gwynns Falls subwatershed portion of the indirect and cumulative effects analysis boundary is located in southwestern Baltimore County and western Baltimore City. This subwatershed is located within the Piedmont Plateau Physiographic Province and roughly follows the Gwynns Falls drainage basin from western Baltimore County south through western Baltimore City. Based on MDP 2002 GIS land use data, the Baltimore County portion of Gwynns Falls subwatershed has 16,369.8 acres of land. The land acres are divided as follows:

- Urban: 12,129.9 acres (74.1 percent)
- Agriculture: 729.5 acres (4.5 percent)
- Forest: 2,516.4 acres (15.4 percent)
- Wetlands: 4.6 acres (< 1 percent)
- Barren land: 936.7 acres (5.7 percent)

The Baltimore City portion of the Gwynns Falls subwatershed has 66.8 acres of open water and 3,983.4 acres of land. The Baltimore City land acres are divided as follows:

- Urban: 2,765.9 acres (68.3 percent)
- Agriculture: 49.1 acres (1.2 percent)
- Forest: 844.3 acres (20.8 percent)
- Wetlands: 0 acres (0 percent)
- Barren land: 218.6 acres (5.4 percent)

Land use in this subwatershed is predominantly residential, forest, and industrial. Historic and current land use trends for the Middle and Lower Gwynns Falls subwatersheds are shown in **Tables 12 – 15**.

Table 14: Middle Gwynns Falls Subwatershed Historic Land Use

Land Use	1973	2002	% Change
Total Developed Residential	9,830.2	11,178.7	13.7%
Total Developed Non-Residential	2,907.8	3,875.5	33.3%
Total Developed	12,738.0	15,054.2	18.2%
Total Resource Lands	7,618.7	5,252.0	-31.1%

Table 15: Middle Gwynns Falls Subwatershed Current Land Use

Land Use	2002	2010	% Change
Low-Density Residential	545.2	577.2	5.9%
Medium-Density Residential	7,795.8	7,626.5	-2.2%
High-Density Residential	2,837.8	3,112.9	9.7%
Commercial	1,730.4	1,666.6	-3.7%
Industrial	615.5	662.3	7.6%
Institutional	1,371.2	1,390.8	1.4%
Open Urban Land	1,108.1	994.3	-10.3%
Forest	3,360.6	3,157.7	-6.0%

3.2 Description of Station Areas

The proposed Red Line would traverse a physically and demographically diverse area in Baltimore County and Baltimore City. The Preferred Alternative would run through suburban areas with low-density development in Baltimore County, to moderately dense neighborhoods of West Baltimore, and through the densely developed downtown central business district (CBD) to the moderately dense neighborhoods of East Baltimore. While the area around each station is unique, general area descriptions are provided in the subsequent sections.

3.2.9 West Segment

There are four stations proposed in the western segment of the Preferred Alternative: Centers for Medicare & Medicaid Services (CMS), Security Square, Social Security Administration (SSA) and I-70 Park-and-Ride are all located in the Woodlawn area of Baltimore County. The general character of these station areas is suburban with low-density housing development and low-density population. All stations would be located adjacent to existing large parking areas. Existing bus ridership ranges from low in the CMS station area to high in the Security Square station area. All stations, except the I-70 Park-and-Ride station, would provide direct access to employment centers. CMS and SSA stations would primarily serve government employment facilities while Security Square station would provide access to a variety of commercial employment and retail services including Security Square Mall.

a. Centers for Medicare & Medicaid Services (CMS) Station Area

The CMS Station area includes single-family detached and duplex homes built in the 1960s. Residential communities within the station area have grown over time in a relatively suburban development pattern. This has resulted in each development having its own architectural character, often having its own recreational facilities such as a community pool or playground, creating its own Home Owner's Association (HOA). Each of these unique characteristics has resulted in a variety of communities with unique identities.

The major institution at this station is the CMS campus. Developed in the mid 1990s, the campus employs several thousand people and is located adjacent to the station. The Chadwick neighborhood consists of homes built in the 1960s and 1970s and is also adjacent to the station.

b. Security Square Station Area

West of Rolling Road is mostly residential neighborhoods, such as the Tuscany Gardens/Tuscany Woods Apartments. East of Rolling Road near Security Boulevard is the Security Square Shopping Center and Security Square Mall, which is one of the largest retail centers in the region. The large 1,040,000 square-foot 1970s-style enclosed mall has, in recent years, lost several large anchor stores and features many discount retail stores. It is served by five bus lines: 15, 20, 40, 44, and 57, and attracts shoppers.

The Security Square station area is a suburban mixed-use center with various land uses immediately adjacent to one another. The land uses north of Security Boulevard are largely strip-mall style commercial businesses including McDonald's, Exxon, a Koons car dealership, and tax services. I-70 to the south and I-695 to the east segment the area and could provide barriers that inhibit access to the proposed station.

Security Square Mall was built in 1972 and currently leases space to around 100 stores. The station would be located to the north of the mall and bounded by I-70 and I-695. Northwest of the mall is commercial and retail development that was constructed after the mall opened. To the south is the Rolling Roads Farm area with homes built in the 1970s and 1980s.

c. Social Security Administration (SSA) Station Area

The station area is mostly composed of single-family housing and apartment complexes and Southwest Academy, a magnet school for Baltimore County. To the north of I-70 and east of Woodlawn Drive, there are multiple SSA office buildings and supporting facilities with surface lots and minimal open space. To the north of I-70 and west of Woodlawn Drive, the land is occupied by SSA West building, Morning Star Baptist Church properties, and multiple retail, car sales and hospitality properties. To the north of Security Boulevard and west of Woodlawn Drive, the area contains older warehouse facilities of light industrial use, some of which have been converted to office space.

South of I-70 is a predominantly residential area with the Southwest Academy as a school anchor. Woodlawn Drive is an important artery to the community. It is a four-lane undivided state road. Parallel Drive and the drive to the Security West Building are two-lane undivided county roads.

The SSA Campus has been in the Woodlawn area since the 1960s, when it was relocated from downtown Baltimore. The station would be located to the south of the campus and north of I-70.

d. I-70 Park-and-Ride Station Area

The I-70 Park-and-ride Station would be located on the south side of Parallel Drive between two parking lots. The station is configured as a center platform with entrances including two access ramps located at either end of the platform.

There are scattered small commercial uses in the immediate station area, with a major commercial corridor to the south along US-40/Baltimore National Pike that includes larger shopping centers. The northwestern quadrant of the station area is largely government and institutional associated with the Social Security Administration. The existing I-70 transportation right-of-way bisects the western half of the station area and includes a cloverleaf interchange near the center of the station area.

East of the station is city parkland: Leakin Park. The park is part of the Gwynns Falls Watershed and Trail system. This wooded natural environment contributes to the character of the surrounding neighborhoods where tree lined streets and residences are nestled within a wooded environment.

The station would be located adjacent to I-70 and a new park-and-ride lot would be constructed to serve as a commuter hub. The site is near the SSA campus and residential neighborhood to the south of I-70. The Maryland portion of I-70 was designed and built in the 1940s and 1950s.

3.2.10 Cooks Lane Segment

There are no stations planned for this segment of the Red Line.

3.2.11 US 40 Segment

Five stations are located within the US 40 segment of the Red Line. Three proposed stations, Edmondson Village, Allendale, and Rosemont would be located in the westernmost part of the Baltimore City along the Edmondson Avenue corridor. The areas around these stations include medium density residential housing in the form of historic single family dwellings, semi-attached, and attached row houses. These housing types are typical within the surrounding neighborhoods which tend to contain low to medium density populations. Existing bus ridership ranges from moderate to high along the Edmondson Avenue corridor.

The area is also developed with an historic shopping center near the proposed Edmondson Village station and other commercial and retail establishments, as well as churches, public schools and a senior housing complex.

Two additional proposed stations are located in West Baltimore: Harlem Park and Poppleton. The Harlem Park and Poppleton areas are predominantly developed with attached row houses. The neighborhoods are divided by the former I-170 expressway, now US 40.

a. Edmondson Village Station Area

The Edmondson Village community has a mix of older established residences and new modern urban dwellings with a suburban feel, yet is supported by a historic shopping/retail center and anchored by civic and educational services. This station area is primarily residential in character, consisting predominantly of historic single-family homes to the west of the station location, with some detached, semi-detached and row house type dwellings in the neighborhoods east of the station. To the west of the proposed Edmondson Village station in the Hunting Ridge neighborhood, there are several historic detached homes.

The Uplands residential development (south of Edmondson Avenue) is under construction. Uplands is projected to be the one of the largest public-private housing developments in the city. The main access into this development is at Swann Avenue. The Edmondson Village shopping center was built on an 11-acre parcel in 1947. The surrounding neighborhoods to the north and west were developed at the same time.

b. Allendale Station Area

The Allendale Station area contains the Lyndhurst and Mary E. Rodman Elementary Schools. The area is bordered by open space parkland at Gwynns Falls/Leakin Park.

The Allendale Station area is primarily residential. Two-story brick row houses, many with porches, frame the local streets. There are also several mid-rise and high-rise senior apartment buildings scattered throughout the area.

The major open spaces in the Allendale station area are the Gwynns Falls Trail and Leakin Park. There are also a number of small parks (Harlem & Dennison Park, Gelston Park, Lyndhurst Park, and Kevin & Woodbridge Park) throughout the station area.

The Allendale neighborhood is adjacent to Gwynns Falls Park and is bisected by Edmondson Avenue. The residences and churches in the area were developed in the 1930s. Scattered single family homes from the 1920s also exist in the neighborhood.

c. Rosemont Station Area

In the vicinity of the proposed Rosemont station there is a mix of row houses, public schools, churches, Gwynns Falls Park, the former Hebrew Orphans Asylum, minimal commercial retail and low-scale manufacturing and warehouse uses.

The Rosemont Station area is primarily residential. The neighborhoods are dominated by two-story row houses. There are several mid-rise and high-rise senior apartment buildings scattered throughout the planning area and a large industrial area south of West Franklin Street and to the east of Franklintown Road referred to as the "West Franklin Triangle."

The former Lutheran Hospital site is located northeast of the station. Coppin State University owns the site and the adjacent historic Hebrew Orphan Asylum. Calverton Middle School and James Mosher Elementary School are the only schools in the immediate station area. There are several churches located throughout the neighborhood.

Gwynns Falls Park is a large regional park that forms the western boundary of the planning area and provides a fourteen mile hiking and biking trail that connects the western edge of the City to downtown.

The neighborhood surrounding the station area consists mainly of row houses constructed prior to 1940. Western Cemetery located in the community dates prior to 1880. Commercial development near the proposed yard is more modern compared to the surrounding area.

d. West Baltimore MARC Station Area

Further east is the existing West Baltimore MARC station, which would provide a connection to the MARC Penn Line. The West Baltimore MARC station area is characterized by medium to high bus ridership, medium density population and medium to moderate density housing, mainly in the form of attached row houses. The area contains some dispersed manufacturing-type land uses, churches and schools, and the former Baltimore American Ice House which is currently vacant. East of the existing MARC station is the remnant of the past I-170 proposed expressway and associated ramps, which abruptly ends east of Pulaski Street. Between the end of the highway and the MARC station, there is a large at-grade parking lot for commuters. The proposed station is planned to contain split platforms with the eastbound platform on West Mulberry Street and the westbound platform one block north on West Franklin Street, both of which would provide access to the adjacent MARC station and the existing commuter parking facility. The split platform provides a challenge in providing connectivity between the eastbound and westbound platforms. This station provides an opportunity for a commuter park-and-ride facility.

The West Baltimore MARC Station area would serve the Penrose/Fayette Street Outreach, Rosemont Homeowners/Tenants, and Midtown-Edmondson neighborhoods. An industrial corridor flanks the Amtrak/MARC Line to the southwest of the station. The largest institutions are Bon Secours Hospital in the southern part of the planning area, and Lutheran Hospital northwest of the station. The houses in the neighborhoods are typically three stories. Houses to the west and south in Evergreen Terrace and Smallwood communities are typically two stories with front porches and gardens. There are several mid-rise and high-rise senior apartment buildings. There are also several schools in the planning area: Calverton Middle School and James Mosher, Harlem Park, Lockerman Bundy, and Bentalou Elementary Schools.

The station area has numerous churches, a number of parks, and a community garden. Union Square is an historic park and district on the southeast boundary. Harlem Park is another historic park in the northeast part of the planning area. It is situated between Calhoun and Carey Streets and is the site of Harlem Park Elementary School.

e. Harlem Park Station Area

The proposed Harlem Park station would be located in the median of the below-grade expressway between Calhoun and Carey streets. Within the vicinity of the proposed Harlem Park station is Harlem Square Park, Franklin Square Park, public schools and churches.

The station would serve the Harlem Park, Upton, Franklin Square, Union Square, and Hollins Market neighborhoods and a portion of the Poppleton neighborhood. The Terraces, a HOPE VI project, is a mixed income community with an adjacent senior housing building. Built in the early 2000s, Heritage Crossing is another HOPE VI project that consists of duplexes and townhouses surrounding an urban green.

Most of the other neighborhoods, including Harlem Park, Upton, Franklin Square, Union Square, Hollins Roundhouse and portions of Poppleton consist of three-story row houses constructed during the mid to late nineteenth century. Larger three-story houses line the main streets like Hollins, Calhoun and Carey Streets. Two-story row houses line the smaller streets or alleys, such as Lemmon Street. Several buildings for senior housing are within the planning area and vary in scale from four to ten stories.

This station is located within the “cut” portion of US 40 in West Baltimore. This highway was originally designed to link up with I-70. The new station would act to further bring together the north and south sides of this neighborhood.

3.2.12 Downtown Segment

There would be five underground stations in the Downtown segment: Poppleton, Howard Street/University Center, Inner Harbor, Harbor East, and Fell’s Point. Three stations would provide access to the downtown CBD via underground stations: Inner Harbor, Harbor East and Fell’s Point. The proposed Red Line would operate in a tunnel beneath West Lombard Street. These three station areas are located in areas with high bus ridership and would provide access to numerous sources of employment. There are few residences in this area; mostly medium to high-rise apartment buildings.

Downtown is a densely developed area consisting of medium to large scale buildings. The west side of Downtown has numerous buildings associated with the University of Maryland Medical Center, as well as entertainment centers, the Hippodrome Theater and the 1st Mariner Arena. The center of downtown has a mix of high-rise commercial and government office buildings north of Pratt Street as well as high-rise residential towers. The east side of downtown contains civic buildings including City Hall and carious commercial office buildings. All areas of downtown are in proximity to the famous Inner Harbor waterfront which is home to several tourist attractions and retail centers including the National Aquarium and the Power Plant complex. Additionally, the Camden Yards baseball stadium, the M&T Bank football stadium and the Baltimore Convention Center are all accessible from downtown.

The Downtown area is dotted with multi-level parking garages and surface parking lots. In addition, infill development opportunities are available throughout downtown. Several streets, such as Pratt and Lombard Streets, are several lanes wide and carry a high volume of traffic. Pratt and Lombard Streets also serve as connectors between I-395 and I-83. Bicycle use is increasing downtown, and bike lanes are now provided on Light and Pratt Streets along the Inner Harbor. Connections from proposed stations would be available to the existing light rail line along Howard Street, the Camden MARC station and to the Metro Subway at Charles Center. Additional connections would be available to numerous bus lines.

a. Poppleton Station Area

The station planning area west of Martin Luther King, Jr. Boulevard is primarily residential, where mid- to late-nineteenth century rowhomes dominate. The rowhomes differ in scale, style and detail. Larger three-story houses typically line the main streets. Two-story rowhomes typically line the smaller streets. There are several buildings for senior housing scattered throughout the planning area. Several communities of public housing are scattered throughout the planning area. Churches and public schools are also located throughout the western portion of the station area. Commercial uses are concentrated along the Baltimore Street corridor an historic “main street” within the neighborhood. The University of Maryland Health Science Research Park is located along West Baltimore Street in the area.

b. Howard Street/University Center Station Area

This station area, in the central business district, is in a neighborhood of varying uses which include businesses, retail, offices, cultural and civic facilities, sporting arenas, hospitality and entertainment services, hotels and restaurants, mid and high-rise residential developments and institutional and educational facilities. The University of Maryland’s professional campus occupies the largest acreage within the station area. It includes the University Medical Center and professional schools.

c. Inner Harbor Station Area

The Inner Harbor Station area has the highest projected ridership along the entire project study corridor. Proximity to other available transit including bus, rail and light rail combined with its central location in the CBD allows this station to serve the Inner Harbor tourist area and the downtown office district. The station area would also serve the financial district, government center, Charles Center, University Center, historic Howard Street retail district and a variety of neighborhoods.

Notable landmark buildings include 100 Light Street tower, Bank of America Tower and Harbor Place Mall, Shot Tower, the Convention Center, the National Aquarium, and the Maryland Science Center.

d. Harbor East Station Area

This station area contains many warehouses and properties that are available for redevelopment. The neighborhood is made up of many new buildings. Jonestown is one of the city’s oldest neighborhoods and is home to businesses along Gay Street as well as the city’s main Post Office on Fayette Street. Baltimore Street and Lombard Street both have retail niches and also include public services. There are two HOPE VI projects within this area: Albemarle Square, which is located just north of Little Italy; and Pleasantview Gardens, which is located just east of the main Post Office. The major development project is the proposed Harbor Pointe development in the Harbor East area.

e. Fell's Point Station Area

Within the Fell's Point Station area, parking is limited in this historic neighborhood, which was constructed prior o the automobile. Because of this, most rowhomes do not have off-street parking. On-street parking is often completely utilized. The parking congestion remains an issue even though several parking garages have been constructed along Caroline Street within the past two decades.

The land use is mostly residential while the primary commercial cores lie along Broadway and Thames Street. The housing surrounding these commercial areas is primarily two- and three-story historic rowhomes. The retail core consists of a variety of uses including general retail, restaurants, cafes and bars. Fell's Point is an entertainment area receiving a large number of visitors from the city and surrounding region.

3.2.13 East Segment

The Red Line would emerge from underground to the east of the Fell's Point station along Boston Street. The next five stations in the east section of the line would serve the Canton, Canton Crossing, Highlandtown and Greektown neighborhoods. These neighborhoods are primarily developed with medium density attached rowhomes, moderate density housing along the Canton waterfront, and commercial retail along Boston Street in Canton and Eastern Avenue near Haven Avenue in Highlandtown. Popular nightlife can also be found in the Canton area especially around O'Donnell Square. New construction in the vicinity of the proposed Canton Crossing station would result in an extensive mixed-use development that would include office, retail, hotel, and residential uses.

The Canton and Canton Crossing stations would also provide easy access to the waterfront and to Patterson Park. In the immediate vicinity of the proposed Highlandtown station are several manufacturing uses. Beyond these are moderate density residential row houses and commercial retail establishments.

The two easternmost stations are located in and around the Johns Hopkins Bayview Medical Center campus. The proposed Bayview MARC Station would primarily serve as a transfer point between the Red Line and the MARC Penn Line with an adjacent surface parking lot for commuters. Johns Hopkins Bayview Medical Center campus would be accessible from this station as well as adjacent manufacturing uses. North of the proposed station is the I-895 expressway, with nearby access to and from I-895 northbound, and existing rail yards. To the south is the Johns Hopkins Bayview Medical Center campus. The station provides an opportunity for a commuter park-and-ride facility.

The eastern terminus of the Red Line would be at the Johns Hopkins Bayview Medical Center campus. This institution is a major employment center similar to those described previously at the western end of the Red Line corridor. In addition to primarily serving hospital staff and patients, the station area would also serve a small residential population located to the south of the hospital campus in medium density attached row houses. The proposed station would likely be located near the center of the campus and would minimize the need for transit riders to walk long distances to access the station.

a. Canton Station Area

Along Boston Street are a number of former industrial sites that have either been redeveloped or renovated. New construction includes a number of townhouse and high-rise residential developments. Former industrial buildings have been renovated for residential reuse. Several of these projects include marinas. This area includes significant open spaces including the Korean War Memorial Park/Canton Waterfront Park (with a boat launch), St. Casmir's Park on Boston Street, O'Donnell Square Park, the Canton Fishing Pier, and Bonvegna Fields. In addition to these open spaces, the Inner Harbor promenade extends from Canton to Downtown.

Approximately half of the station area consists of single-family residential properties with some distributed retail. This area is northeast of the proposed station. The remaining half of the station area contains undeveloped former industrial sites and mixed-use development.

The Canton neighborhood has many walkable streets, parks, restaurants and retail establishments, and offers access to marinas and the waterfront. It has existing parks along the waterfront and Boston Street. The neighborhood also provides access to O'Donnell Square Park, which is surrounded by retail properties and is very active.

b. Brewers Hill/Canton Crossing Station Area

The primary retail and office areas are north of Boston Street in Brewers Hill site and south of Boston Street in the Canton Crossing development. Former industrial sites are located north and south of Boston Street between Haven Street and Baylis Street. Both of these sites' master plans call for dense urban development. Brewers Hill has completed renovations of the buildings north of O'Donnell Street for office and retail use and a storage facility. The 1st Mariner office tower is complete, as is retail and office along Boston Street.

The Canton Crossing station area is a unique neighborhood because it has several historic structures, an established residential area and is close to the Inner Harbor. Some historic properties have already been restored and repurposed with office space, including the National Brewing Company building and one of the Gunther Brewing Company buildings.

c. Highlandtown/Greektown Station Area

The Highlandtown/Greektown Station would serve Greektown, Highlandtown, local businesses, recreational facilities, and educational facilities in the area. The station area is also served by several bus lines.

The Eastern Avenue corridor creates a retail spine through these communities. The shops create traditional main streets with small shops creating an urban edge along sidewalks. Highlandtown and Greektown have community development corporations and active merchants associations.

Greektown has been home to a thriving Greek/Greek American community since the 1930s. Once known simply as The Hill, during the 1980s its residents petitioned the city to change the name of the neighborhood to Greektown. Today it is a diverse community of people with various ethnic backgrounds.

d. Bayview Campus & Bayview MARC Station Areas

The Bayview Campus Station is located just west of the intersection of Bayview Boulevard and Alpha Commons Drive. The Red Line alignment and proposed station would run parallel to the north side of Alpha Commons Drive.

The Bayview MARC Station is located south of the existing MARC right-of-way. The station would serve as a commuter station with on-site parking and a direct connection to a proposed MARC station. The station is planned to become one of several intermodal stations.

To the east of the station location is the Joseph Lee neighborhood, which is primarily of a residential character. This is a residential neighborhood of mainly two-story row houses. To the southwest of the station location is the Greektown neighborhood. This neighborhood is primarily residential with two-story rowhomes. The area is also home to a high concentration of restaurants primarily located along the Eastern Avenue corridor. Restaurant options range from typical Greek restaurants to more recently added Hispanic fare.

To the southeast of the station location is the Bayview business district. This district is characterized by a mix of small stores located in rowhomes, big box chain stores, and suburban style drive-up stores primarily located along Eastern and Dundalk Avenues. The Pemco Site and the Crown Industrial Park are a few of the larger abandoned developments in the station area. There is a commercial area around the intersection of Eastern and Dundalk Avenues. Next to Bayview Campus are a fire department and the District Police Station.

The Johns Hopkins Bayview Medical Center campus consists of the medical center, which includes the region’s burn center; National Institute of Health facilities and health and research specialty facilities such as the Asthma Center; and research and development facilities. The master plan for this campus allows for substantial additional growth. The site is located on a hill, which allows for visibility from a distance. The campus includes open space and a stormwater management pond along Eastern Avenue which allow for open space amenities for the campus and surrounding communities.

4. Potential Indirect and Cumulative Effects

Potential indirect and cumulative effects to resources in the project study corridor are analyzed within two main sub-boundary areas, watersheds and station areas (as summarized in **Table 1**). Indirect effects are those resulting from the potential for induced development spurred by the Red Line project. Subsequent development projects, beyond those already planned or programmed, are expected to be minimal because of the predominantly urban and built-out nature of the Red Line project study corridor. Any future projects would most likely consist of redevelopment of vacant parcels located near station areas. This potential effect would have a positive effect on the surrounding communities.

4.1 Future No-Build Conditions

The No-Build Alternative would not directly or indirectly affect any of the factors within the indirect and cumulative effects analysis boundary as the Red Line would not be constructed under the No-Build Alternative. Though the No-Build Alternative would not involve any project-related construction, there would be changes to the environment and land use as a result of other unrelated projects.

4.2 Preferred Alternative

This section discusses the potential indirect and cumulative effects to environmental resources within the overall indirect and cumulative effects analysis boundary and associated with the Red Line Preferred Alternative. Indirect effects are caused by the action (construction of the Preferred Alternative) and are later in time or farther removed from the immediate study area, but still reasonably foreseeable. Indirect effects include land use changes that area caused by the proposed action, including new development, changes in the pattern of development, and changes in the rate of development. Coordination with Baltimore City and Baltimore County planning agencies has determined that there are no development projects dependent on the construction of the Red Line project.

Cumulative effects include impacts on environmental resources which would result from incremental effects of the Preferred Alternative when added with other past, present, and reasonably foreseeable future actions. Typically, cumulative effects would result from public or private development that may or may not be associated with the Red Line.

As part of the indirect and cumulative effects analysis, all direct effects of the Preferred Alternative were evaluated. Potential indirect and cumulative effects were assessed within the overall indirect and cumulative effects analysis boundary by either the subwatershed area in which they are located or by the station area they are located closest to.

4.2.9 Indirect and Cumulative Effects by Subwatershed

Effects to the following resources were assessed within the subwatershed sub-boundary: land use, air quality, floodplains, and forested areas.

a. Land Use

Operation of the Preferred Alternative would result in minimal changes in land use as most of the Preferred Alternative would be located within existing transportation right-of-way. In addition, the Preferred Alternative would support planned growth in the project study corridor in a manner consistent with Baltimore County and City's plans, policies and zoning.

The Preferred Alternative could indirectly increase the rate of development within the framework of the existing land use patterns. The potential for growth and land use changes in the region as a result of the proposed project is low, with the exception of redevelopment of vacant parcels and undeveloped areas, particularly near the planned Red Line stations. If this occurs, it could cause gentrification of neighborhoods and potentially spur the loss of some affordable housing. The majority of the land within indirect and cumulative effects analysis boundary is developed; therefore, a large influx in private development is unlikely. The extent, pace, and location of development within the indirect and cumulative effects analysis boundary would primarily be influenced by State, County and local land use regulations. Therefore, the Red Line is not expected to induce other projects, land use changes, or zoning changes, but may induce indirect effects caused by increases in the rate of development.

Cumulative effects to the land uses within the indirect and cumulative effects analysis boundary are anticipated to be minimal. The Red Line could cause changes to the rate of development in the area. Thus, when added to the potential increase in rate of development spurred by other unrelated development projects, this could result in the stimulation of development rates within designated growth areas. Although growth would be occurring in designated areas, the increased rate of development may result in faster conversion of land to a different use. This effect would be minimal due the built out nature of the land within the indirect and cumulative effects analysis boundary. Further, both Baltimore City and Baltimore County have made accommodations in their respective long-range plans to account for the possible existence of the Red Line. These factors would result in little to no cumulative effects on land use within the indirect and cumulative effects analysis boundary.

Existing land use regulations limit the amount and location of development prior to the completion of any project. Zoning regulations are in place to guide development to designated areas, thus managing potential adverse and unwanted effects to surrounding land use.

Transit Oriented Development

Transit Oriented Development (TOD) refers to development areas that include relatively higher density than the immediate surroundings that may include a mixture of residential, business, shopping, and civic uses and types, located within walking distance of a transit center. TOD can effectively create amenities for existing transit riders, generate new ridership through housing and destinations, reduce auto-dependency, and attract new investments to the area.

The Baltimore City Department of Planning has developed transit-supportive land use strategies to create compact, pedestrian-friendly activity zones near transit stations. In planning for future transit station areas they have partnered with the Maryland Department of Transportation (MDOT), MTA, and Baltimore County to investigate land use policies that support transit as part of the Red Line project.

The station area planning process has included in-depth community outreach and land use, and zoning analysis to help extend and integrate Baltimore's transit system and to leverage transit investments towards achieving community goals.

The potential for growth and land use changes as a result of the proposed project is low as most of the area within the project study corridor contains neighborhoods in an urban or suburban setting. Overall, the proposed project is not likely to cause a substantial change in type or intensity of land use.

Indirect effects from TOD within the project study corridor would be generally positive particularly in western and downtown Baltimore City, where vacancy rates are high. It is anticipated that overall cumulative effects would be beneficial from a corridor system perspective as the Preferred Alternative would provide a benefit to the traveling public with new and expanded transit service. Improved connectivity and accessibility; reduced dependency on auto use; and reduced roadway congestion, and associated air pollution emissions and energy consumption are some of the benefits.

b. Air Quality

The emission burden analysis of a project determines a project's overall effect on regional air quality levels. This analysis takes the following pollutants into consideration: carbon monoxide, nitrogen oxides, volatile organic compounds, and particulate matter. The Preferred Alternative is predicted to decrease regional pollutant burdens by approximately 1.5 to 1.9 percent.

Indirect effects to air quality resulting from the Red Line are not anticipated. The project may encourage redevelopment of small vacant parcels surrounding station areas; however, this development would not have a significant effect on air quality.

While there are no planned transportation improvements dependent upon the completion of the Red Line, the addition of other transit improvements in the region could lead to cumulative improvements to air quality.

c. Floodplains

The floodplains that would be directly affected fall within the Western, Downtown Tunnel, and Eastern segments of the Red Line. The Red Line would impact 0.7 acre of non-tidal 100-year floodplains and 1 acre of tidal 100-year floodplains.

Planned development and transportation projects within the indirect and cumulative effects analysis boundary were assessed by comparing planned projects with floodplain boundaries to evaluate potential indirect and cumulative impacts. The majority of the floodplains within the indirect and cumulative effects analysis boundary are within areas that are developed or are within protected parkland areas. The Preferred Alternative is not expected to change land use patterns, but could induce an increase in the rate of development within planned growth areas, which could result in indirect effects to floodplains. Most floodplain areas are protected from development through land use and zoning regulations.

Cumulative effects to floodplains from the Red Line when combined with other planned projects are possible. Disturbance to floodplain vegetation and landscapes may cause loss of hydraulic function. This loss could cause increased flooding, erosion and sedimentation, thus affecting downstream channel morphology. Future development would have minimal effect to 100-year floodplains because of existing regulations and the requirement for approval from the Maryland Department of Environment (MDE). Permits requiring avoidance, minimization, and mitigation would offset most floodplain disturbances caused by cumulative effects.

d. Forested Areas

The Preferred Alternative would affect 34.8 acres of forested area and 39 specimen trees in Baltimore County and Baltimore City.

Present and future development projects and transportation projects were compared with the land use plans to determine the potential indirect and cumulative effects to forested areas. Most of the large, contiguous parcels of woodlands are located in protected parkland areas and along streams within the indirect and cumulative effects analysis boundary and are subject to protection from development.

Indirect effects to forested areas could occur as a result of the Preferred Alternative. The Preferred Alternative is not expected to change land use patterns, but could cause an increase in the rate of development which would cause a faster conversion of forested areas to developed areas where growth is designated. A change in the rate of development could adversely affect woodland species and degrade habitat areas. However, woodland conversion would not be inconsistent with historical trends of land use change in the state of Maryland which shows that over the last 50 years, Maryland has lost an average of 7,200 acres of forested woodland each year (Maryland Department of Natural Resources, 2003).

Cumulative effects to forested areas could occur when the Preferred Alternative is combined with other future transportation and development projects. Cumulative effects are most likely to occur in areas designated for development. Wildlife species would be affected from continued loss of habitat or habitat fragmentation. Indirect and cumulative effects to forested areas would be minimized and mitigated by the state and local laws and regulations.

4.2.10 Indirect and Cumulative Effects by Station Area

Effects to the following resources were assessed within the station area sub-boundary: community facilities and services, demographics and environmental justice, economic conditions, public parks and recreational facilities, cultural resources, noise and vibration, street trees, hazardous materials, and utilities.

a. Community Facilities and Services

The Preferred Alternative would affect several properties owned or used by community facilities throughout the corridor. Affected facilities include schools, places of worship, cemeteries, and medical facilities. Portions of the properties of community resources may be acquired permanently, used under a permanent easement, or used during construction through temporary easements. The proposed effects either consist of property sliver takes or effects to ancillary facilities such as parking areas or driveways. None of the properties would be fully acquired or displaced and no buildings housing community facilities or services would require permanent relocation.

Direct effects to bus service include: modifications to existing bus routes operating within the project study corridor; new feeder bus service to directly serve Red Line stations and other rail mode stations allowing passengers to transfer to light rail, heavy rail or commuter rail service. Increased access and reduced congestion resulting from the Red Line project are anticipated to improve emergency response times overall within the project study corridor. However, delays from gated crossings could increase response times along those routes.

Also, the elimination of some available on-street parking spaces may result in indirect effects to the surrounding communities, particularly near proposed stations. With fewer spaces available along the Preferred Alternative alignment (particularly along Edmondson Avenue and Boston Street), there could be more parked vehicles on surrounding side streets and a shortage of available spots in these areas. However, current parking restrictions would be eliminated along portions of Edmondson Avenue under the proposed parking configuration. The MTA is committed to working with Baltimore City to identify opportunities to offset the loss of parking during construction and in the long-term.

Cumulative effects to community facilities and services are anticipated to be minor. Future transportation development could incrementally affect community resources by putting added strain on the resources. However, the Preferred Alternative would not alter the pattern of development already affecting the communities surrounding the station areas.

b. Demographics and Environmental Justice

There are 30 communities located throughout the project study area that have US Census tracts that meet environmental justice thresholds, as listed in **Table 16**.

Table 16: Environmental Justice Communities and Census Tracts

Neighborhood	Corresponding US Census Tracts
Allendale	2007.01
Downtown	0401.00, 0402.00
Edmondson Village	1608.01, 1608.02
Fell's Point	0202.00, 0301.00
Franklin Square	1901.00, 2001.00
Franklintown Road	1606.00, 1607.00
Gwynn Oak	4011.01, 4011.02, 4012.00, 4013.01, 4013.02
Gywnns Falls/Leakin Park	1607.00, 1608.02, 2803.01, 2804.02
Harlem Park	1601.00, 1602.00, 1603.00, 1604.00, 1801.00, 1802.00, 1901.00, 2001.00
Heritage Crossing	1703.00, 1801.00
Highlandtown	2608.00, 2609.00, 2611.00

Table 16: Environmental Justice Communities and Census Tracts

Neighborhood	Corresponding US Census Tracts
Hollins Market	1803
Hunting Ridge	2804.01
Inner Harbor	0302.00, 0401.00, 2201.00
Jonestown	0302.00, 2805.00
Kresson	2604.04
Little Italy	0301.00, 0302.00
Midtown-Edmondson	1604.00, 1605.00, 2001.00
Mosher	1606
Penrose/Fayette Street Outreach	1606.00, 2001.00, 2002.00
Poppleton	1801.00, 1802.00
Pulaski Industrial Area	2604.04
Rognel Heights	2804.01, 2804.02
Rosemont Homeowners/Tenants	1605.00, 1606.00
Ten Hills	2804.03
University of Maryland	402
Uplands	2804.04
West Hills	2804.01
Westgate	2804.03
Windsor Mill	4015.05, 4015.06, 4015.07

The Preferred Alternative is anticipated to have minor direct effects on the environmental justice communities along the alignment. There would be partial property acquisitions associated with the Preferred Alternative, but these would be small sliver takes of property directly adjacent to the alignment and would not affect the function or use of most properties. The Preferred Alternative is expected to result in positive effects for the local communities by improving accessibility and mobility, reducing travel times and improving efficiency.

The Preferred Alternative is not expected to change land use patterns, but could cause an increase in the rate of development within planned growth areas, which could result in indirect effects to environmental justice populations. Potential indirect effects to environmental justice populations include the reduction in available affordable housing which could result from redevelopment of vacant or under-utilized areas surrounding proposed stations.

Cumulative effects to environmental justice populations could occur as a result of future development within the indirect and cumulative effects analysis boundary, specifically surrounding the stations that would convert affordable housing to areas where the existing population could not afford to live. Cumulative effects are most likely to occur in areas designated for residential development. Given the current land use and pattern of land use development, the areas that are most likely to incur changes in housing affordability are in potential TOD locations.

c. Economic Conditions

The Preferred Alternative would result in direct effects to businesses both permanently (displacements) and temporarily (during construction). As a result there may be permanent loss of some businesses that are directly affected and do not choose to relocate within the project study corridor. Within the station areas, indirect effects such as changes to the greater community structure (community interaction and the location of some businesses) would occur near the areas of direct effect. Property from thirty-seven commercial and industrial parcels throughout the corridor would be permanently acquired (partial property acquisitions), totaling 572,184 square feet. An additional 14 commercial and industrial properties would be fully acquired, totaling 577,459 square feet. Permanent commercial and industrial property acquisitions are listed in **Table 17**, by segment. Detailed information of property impacts may be found in the *Property Acquisitions and Displacements Technical Memorandum*.

Table 17: Permanent Commercial and Industrial Right-of-Way Requirements

Type of Property	Partial Property Acquisitions # (square feet)	Total Property Acquisitions # (square feet)
West Segment		
Commercial	8 (211,470)	0
Industrial	1 (45,524)	0
Cooks Lane Tunnel Segment		
Commercial	1 (4,968)	0
US 40 Segment		
Commercial	11 (4,717)	1 (8,870)
Downtown Tunnel Segment		
Commercial	1 (2,205)	6 (63,809)
East Segment		
Commercial	3 (69,483)	0
Industrial	12 (233,817)	2 (212,916)
Operations and Maintenance Facility		
Commercial	0	4 (218,846)
Industrial	0	1 (73,018)
Total		
N/A	37 (572,184)	14 (577,459)

Indirect effects of the Preferred Alternative include long-term benefits for the communities it traverses. The Red Line would further goals and policies for revitalization and investment within the indirect and cumulative effects analysis boundary. The fiscal benefits of Red Line operation would have a long-term, positive effect for the surrounding communities. Indirect effects to area businesses may include changes to the intensity of development or the timing of proposed development, because of modifications in access and traffic patterns that would occur with the construction of the Preferred Alternative particularly surrounding stations.

The Preferred Alternative is expected to have positive cumulative effects to the economy within the project study corridor. Cumulative effects to businesses and the economic environment could include additional businesses migrating to the station areas to serve the users of the Red Line. Cumulative effects on local employment would also be beneficial. Future development could create more jobs for local residents, increase available housing in the area, and improve mobility and accessibility for commuters.

d. Public Parks and Recreational Facilities

Under the Preferred Alternative, permanent direct effects are anticipated to affect two park and recreation areas. Less than 0.1 acre would be permanently acquired from each resource as part of the Red Line project. The access to and use of the facilities would not be affected.

The Preferred Alternative is not expected to change land use patterns, but may cause indirect effects to parkland as a result of changes in the rate of development. This is anticipated to be minor because of the existing land use and developed nature of the station areas.

Cumulative effects to public parks and recreational facilities could occur within areas designated for growth where there is potential for build out. The Red Line project study corridor does not contain many vacant or unused properties in the vicinity of the station areas. Cumulative effects to parkland resulting from Federally-funded transportation projects would be regulated through existing laws, including Section 4(f) of the US Department of Transportation Act of 1966, which prohibits the use of park and recreational facilities for transportation uses unless there is no feasible and prudent alternative, or the use is determined to de minimus impact.

e. Cultural Resources (Built Historic Properties and Archaeological Sites)

Built historic properties in the project study corridor have been evaluated for direct effects. The Preferred Alternative would have an adverse effect on five architectural historic properties: Poppleton Fire Station No. 38, Business and Government Historic District, South Central Avenue Historic District, Fell's Point Historic District, and Public School No. 25 (Captain Henry Fleete School).

Indirect effects to cultural resources could occur by increasing the rate at which potential areas are redeveloped, particularly at vacant sites adjacent to station areas. Although it is not anticipated that adverse cumulative effects to cultural resources would result from the proposed project, other planned and programmed projects could cause cumulative effects to some historic and archeological resources in the project study corridor. Any potential effects resulting from proposed federal actions would be mitigated through either the Section 4(f) of the 1966 Department of Transportation Act or Section 106 of the National Historic Preservation Act.

f. Noise and Vibration

The Red Line would introduce new noise sources into the environment which may cause impact to sensitive receptors primarily because of pass-bys from light rail vehicles. Corridor wide vibration levels are predicated to increase under the Preferred Alternative, particularly near pass-bys and switches.

Minor indirect noise effects from changes in land use are anticipated only in areas where redevelopment may occur. However, small-scale redevelopment on vacant properties, particularly near station areas, would typically not create a permanent increase in noise or vibration within the area communities. Only temporary increases in noise and vibration would be anticipated during construction.

Cumulative effects to noise and vibration could occur with the construction and operation of future transportation developments within the indirect and cumulative effects analysis boundary. Any cumulative noise effects would be controlled by the local noise ordinances in place and, depending on the project type, could be regulated by the MDE, Federal Highway Administration (FHWA) or Federal Transit Administration (FTA).

g. Street Trees

The Preferred Alternative would result in the removal of 315 street trees in Baltimore County and 948 street trees in Baltimore City.

All street tree effects would be confined to the limit of disturbance for the Preferred Alternative and based on the required mitigation, the anticipated indirect effects to street trees would result in no net loss of trees. During construction accidental spills and sediment and/or concrete washout releases into forest/hedgerow retention areas could affect the health and vigor of edge street trees. After construction is complete, the residual effects from removal of select street trees could negatively affect the health of some remaining street trees because of sun scorch, adjacent changes in grading or slope, or changes to soil moisture etc.

Cumulative effects to street trees could occur when the Preferred Alternative is combined with other future transportation and development projects. Cumulative effects are most likely to occur in areas designated for development or redevelopment, particularly surrounding stations. In these areas, wildlife species could be affected from continued loss of habitat or habitat fragmentation.

Indirect and cumulative effects to street trees would be minimized and mitigated by Baltimore City through the administration of its own roadside/street tree regulations (in lieu of Department of Natural Resources enforcement of the Roadside Tree Law).

h. Hazardous Materials

The Preferred Alternative has a number of potential direct effects throughout the corridor, specifically the potential areas for contamination include former and current industrial sites and they vary within each segment. **Table 18** lists the type of risk for each segment.

Table 18: Hazardous Material Contamination Risk

Segment	Impact Risk Type		
	Slight	**Moderate**	**High**
West Segment	Yes	No	No
Cooks Lane Tunnel Segment	No	Yes	No
US 40 Segment	Yes	Yes	No
Downtown Tunnel Segment	Yes	Yes	Yes
East Segment	Yes	Yes	Yes

There are four station sites (Social Security Administration, Edmondson Village, Harlem Park, and Brewers Hill/Canton Crossing) along the alignment where there are concerns for contamination including petroleum, metals, chromium, and dry cleaning solvents. These impacts are summarized in **Table 19**. Potential effects from the Preferred Alternative would be managed by employing a number of mitigation techniques during the construction of the alignment including the implementation of a health and safety plan, segregating contaminated materials, and exercising proper treatment and disposal of contaminated materials.

Table 19: Hazardous Material Contamination at Stations

Proposed Station	Suspected contaminants of concern	Sampling Locations	Summary of Sampling Results
Social Security Administration Station	None	1-STA-SSA-B-002	Chromium was reported in the soil sample at a concentration that exceeded MDE cleanup standards.
Edmondson Village Station	Petroleum	3-LR-B-003	Elevated VOCs were detected during the field screening of both borings. Arsenic was reported in the soil sample collected from 3-STA-EV-B-001at a concentration that exceeded MDE cleanup standards.
		3-STA-EV-B-001	
Harlem Park Station	Petroleum and Dry Cleaning Solvents	3-STA-HP-B-001	Arsenic was reported in the soil sample at a concentration that exceeded the MDE cleanup standards.
Brewers Hill/Canton Crossing Station	Petroleum and Metals	5-STA-CC-001	Minimal VOCs were detected during the field screening. An elevated concentration of GRO was reported in the soil sample. DRO exceeded the MDE cleanup standards.

The Preferred Alternative is not expected to have indirect effects resulting from changes in land use are anticipated. Increases in the rate of development could ultimately create the opportunity for greater discovery of hazardous material deposits and associated remediation of those areas. The increased potential for discovery and remediation would be a positive indirect effect of the project.

Based on the analyses conducted by the project team, there are a number of potential indirect hazardous material impacts along the alignment and near the station areas. These effects include the possibility of elevated chromium, VOC, and arsenic levels in soil samples around four station areas, moderate hazardous risk levels at stations in the Cooks Lane Tunnel, US 40, Downtown Tunnel, and East segments and high hazardous risk levels at stations in the US 40, Downtown Tunnel, and East segments.

Any new development or redevelopment activities in the area are not expected to release contaminants because of the strict regulations in place regarding hazardous materials. Redevelopment of previously contaminated properties offers the potential to further remediate residual contaminated soils and groundwater that may not have been treated before the current regulatory laws were established. This potential cumulative effect would be an overall benefit to the environment.

Any hazardous materials encountered by construction of a development or transportation project unrelated to the Red Line is required to be properly treated and disposed of as per MDE regulations.

i. Utilities

The Preferred Alternative would have extensive direct utility effects because of the significant number of utilities located within the project study corridor. Utilities in direct conflict would be relocated in accordance with the utility owner's standards and the Project Design Criteria manual.

Indirect effects to utilities are not anticipated because the project would not require the construction of new utility infrastructure for developments that are not related to the operation of the Red Line. After construction of the Preferred Alternative is complete, construction of any utility that requires replacement or relocation as a result of effects associated with the Red Line project would be in place. Separate planned transportation improvement and development projects throughout the Red Line project study area, and their respective effects to major utilities, would be addressed as part of their respective designs and construction.

The Red Line project, in combination with other future development, could result in cumulative effects to utilities within the indirect and cumulative effects analysis boundary and surrounding the station areas in the form of increased strain on the existing utilities. As is typical for any utility infrastructure, there would be ongoing system preservation efforts which include periodic maintenance and construction that would affect distribution and service.

4.2.11 Avoidance and Minimization

Potential indirect negative effects resulting from the project have been and would continue to be minimized through the alignment design and station area planning process, which will continue to include public outreach to residents and communities surrounding station locations.

4.2.12 Mitigation

The Council on Environmental Quality (CEQ) regulations, which implement NEPA, requires that Environmental Impact Statements include the consideration and discussion of possible mitigation for project impacts. Measures that would be appropriate to offset most indirect and cumulative effects will be beyond the control and funding capability of the MTA and FTA. The pace and extent of future development within the indirect and cumulative effects analysis boundary will be influenced and controlled by the state, county and city land use plans and policies. MTA will encourage state and local planning agencies that can influence development patterns and promote the benefits of controls that incorporate environmental protection into all planned development.

Possible mitigation strategies for indirect and cumulative effects could be considered by the responsible parties, including state and local planning agencies. These strategies may include low-impact development measures, land use management through planning regulations and zoning, and public education on the benefits of environmental conservation and smart growth.

Possible mitigation measures include specific zoning recommendations to minimize effects on notable features and area neighborhoods, and discourage development within adjacent neighborhoods located outside of the station areas or other areas where development is slated to occur.

Specific mitigation commitments for direct effects from the Preferred Alternative are identified throughout **Chapter 5** in each of the technical sections, when applicable.

5. Conclusions

The indirect effects caused by the Red Line later in time are expected to be minor; the incremental effects of the Red Line when added to other past, present, and reasonably foreseeable future action (that is the cumulative effects of the project) are anticipated to be minor.

Potential indirect negative effects resulting from the project would be minimized through the station area planning process, which will continue to include public outreach to residents and communities surrounding station locations. Mitigation measures identified during this process could include specific zoning recommendations to minimize effects on notable features and area neighborhoods, and discourage development within adjacent neighborhoods located outside of the station areas or other areas where development is slated to occur.

Throughout the planning phase of this project, MTA reduced the potential for incremental impact of other past, present, and reasonable foreseeable future actions by working closely with area agencies, institutions, private landowners, and developers to develop transit improvements that meet the needs of the community and are congruent with the existing surroundings.

Based on the cumulative effects assessment, there are minor projected incremental impacts of the proposed action that combine with other past, present, or reasonably foreseeable future actions that would result in a significant impact.

6. References

American Community Survey 2010 (5-Year Estimate)

Baltimore City Department of Transportation, Division of Planning

Baltimore Neighborhood Indicator's Alliance (BNIA)
http://www.bniajfi.org/neighborhood_data

Baltimore City Neighborhoods website. http://www.livebaltimore.com/neighborhoods/list/

Baltimore County Office of Planning, Neighborhood Mapping Tool
http://www.baltimorecountymd.gov/Agencies/infotech/GIS/MyNeighborhood/index.html

Baltimore Regional Transportation Board

Live Baltimore non-profit organization http://www.livebaltimore.com/neighborhoods/list/

LIVE EARN PLAY LEARN: Baltimore City Comprehensive Master Plan 2008 Evaluation Report

Maryland Department of Natural Resources

Maryland Department of Planning's Priority Places webpage
http://www.mdp.state.md.us/OurWork/smartGrowth.shtml

Maryland Department of the Environment

Maryland Department of Transportation, Office of Planning and Capital Programming

US Census Bureau, 2000 & 2010
www.census.gov

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION

MARYLAND TRANSIT ADMINISTRATION

Baltimore, Maryland

Baltimore Red Line

Red Line General Engineering Consultant

Noise and Vibration Technical Report
December 2012

Document No.
1732

Table of Contents

ES. EXECUTIVE SUMMARY

As part of the Maryland Transit Administration's (MTA) proposed Red Line Light Rail Transit (LRT) project between Woodlawn and the Johns Hopkins Medical Center at Bayview, a noise and vibration assessment was prepared in accordance with the National Environmental Policy Act (NEPA). The environmental analyses are intended to document potential impacts related to noise and vibration because of the operation and construction of the LRT alignment and associated ancillary facilities. This technical report was prepared as part of the project's Final Environmental Impact Statement (FEIS).

The operational impacts were evaluated using the guidelines set forth by the Federal Transit Administration's (FTA) *Transit Noise and Vibration Assessment*[1]. The temporary construction impacts were also evaluated using both the FTA guidelines and the Federal Highway Administration's (FHWA) Roadway Construction Noise Model (RCNM). The temporary impacts because of construction activities were evaluated using the Noise Control Policy from the Maryland Department of the Environment (MDE).

In most cases, project noise levels from LRT operations are predicted to be well below the existing ambient noise levels. Even so, the Preferred Alternative is expected to create some noise impacts, as described below. Where impacts are predicted, "feasible and reasonable" noise control measures were evaluated to mitigate the predicted impacts in accordance with FTA guidance in existing high-noise environments. However, none of the "feasible and reasonable" mitigation measures would reduce noise from existing traffic, which is the primary source of noise in the community. Therefore, future noise levels with mitigation would remain similar to current levels.

Design year noise and vibration impacts may occur in residential and other noise-sensitive areas located in proximity to the project. Three noise-and vibration-sensitive land use categories were evaluated for this project: medical laboratories (FTA Category 1), residential (FTA Category 2) and institutional (FTA Category 3). At residences, the 24-hour day-night noise level was used to assess impacts, particularly during the nighttime periods when people are sleeping. At non-residential and institutional receptors, such as medical laboratories, schools, parks, museums and libraries, the peak-hour average noise levels were used to assess daytime impacts. Noise and vibration impacts may be generated during both construction and operation of the Red Line Project.

The No-Build Condition is not expected to change existing noise levels in the project study corridor because traffic, the primary source of the existing noise in the area, is already at or above road capacity and therefore cannot increase to an extent that it would create new noise impacts. Since new sources of noise or vibration from the project would not be added, noise and vibration impacts are not expected. The No-Build Condition involves no construction; therefore, there are no noise or vibration impacts predicted for the No-Build Condition.

---

[1] Federal Transit Administration, "Transit Noise and Vibration Impact Assessment", Washington, DC, May 2006

The Preferred Alternative is predicted to result in one *severe* noise impact and 96 *moderate* noise impacts at residences (FTA Category 2 land uses). Future noise levels along the project study corridor are, however, not predicted to exceed the FTA Category 1 or 3 impact criteria at any medical or institutional receptors.

Additionally, future vibration levels from LRT operations are predicted to result in 45 exceedances of the FTA *frequent* criterion of 72 VdB for residential land uses and one exceedance of the site-specific criterion of 40 VdB (100 μips) for the proposed University of Maryland Proton building. However, no exceedances of the site-specific criterion of 50 VdB (300 μips) are predicted at the National Institute of Health building at the Johns Hopkins Bayview Medical Center. Proposed mitigation measures to eliminate noise and vibration impacts predicted along the Preferred Alternative could include approved control measures such as low-profile barriers, low-noise crossing bells, relocation of switches, ballast mats under switches, spring frogs or other “gapless” switches, or other supplemental safety measures at-grade crossings. With the proposed mitigation measures, all potential noise and vibration impacts from operations would be less than significant.

Similarly, appropriate noise and vibration control measures would also be implemented by MTA’s contractors to minimize any potential impacts during temporary construction activities. Proposed mitigation measures could include substituting equipment with lower noise and vibration levels (such as augering versus using pile drivers) or conducting a pre-construction survey of any buildings potentially susceptible to construction vibration. Implementation of proposed mitigation measures would ensure that potential impacts to sensitive and/or historic buildings would be reduced to a less than significant level.

1. Introduction and Methodology

As part of the Maryland Transit Administration's (MTA) proposed Red Line Light Rail Transit (LRT) project, a noise and vibration assessment was conducted in accordance with the National Environmental Policy Act (NEPA) and the guidelines set forth by the Federal Transit Administration (FTA). The environmental analysis is intended to document potential impacts related to noise and vibration because of the operation and construction of the LRT alignment and associated ancillary facilities. This technical report was prepared as part of the project's Final Environmental Impact Statement (FEIS).

The operational impacts were evaluated using the guidelines set forth by the Federal Transit Administration's *Transit Noise and Vibration Assessment*[1]. The temporary construction impacts were also documented using both the FTA guidelines and the Federal Highway Administration's (FHWA) Roadway Construction Noise Model (RCNM). These temporary impacts because of construction activities were evaluated using the Noise Control Policy from the Maryland Department of the Environment (MDE). Finally, traffic noise impacts because of the re-alignment of Interstate 70 were evaluated using the State Highway Administration's *Highway Noise Policy*.

[1] Federal Transit Administration, "Transit Noise and Vibration Impact Assessment", Washington, DC, May 2006

2. Project Description

The Red Line is a 14.1-mile light rail transit line that would operate from the Centers for Medicare & Medicaid Services (CMS) in Baltimore County to the Johns Hopkins Bayview Medical Center campus in Baltimore City. The transit way includes a combination of surface, tunnel and aerial segments, stations, park-and-ride facilities, system elements, tunnel ventilation and a light rail vehicle storage and maintenance facility.

2.1 Human Perception of Noise and Vibration

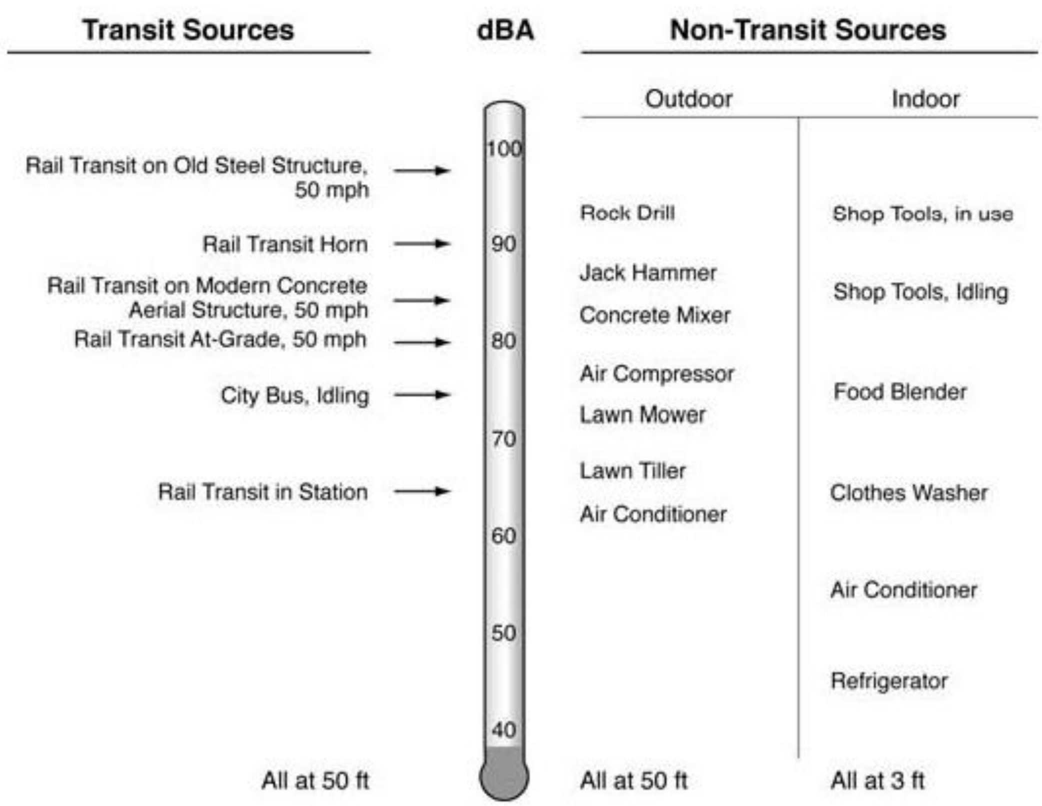
2.2.1 Noise

Noise is “unwanted sound” and, by this definition, the perception of noise is a subjective process. Several factors affect the actual level and quality of sound (or noise) as perceived by the human ear, and can generally be described in terms of loudness, pitch (or frequency), and time variation. The loudness, or magnitude, of noise determines its intensity and is measured in decibels (dB) that can range from below 40 dB (the rustling of leaves) to over 100 dB (a rock concert). Pitch describes the character and frequency content of noise, such as the very low “rumbling” noise of stereo subwoofers or the very high-pitched noise of a piercing whistle. Finally, the time variation of noise sources can be characterized as continuous, such as with a building ventilation fan; intermittent, such as for trains passing by; or impulsive, such as pile-driving activities during construction.

Various sound levels are used to quantify noise from transit sources, including a sound’s loudness, duration and tonal character. For example, the A-weighted noise level (dBA) is commonly used to describe the overall noise level because it more closely matches the human ear’s response to audible frequencies. Because the A-weighted scale is logarithmic, a 10 dBA increase in a noise level is generally perceived as a doubling of loudness, while a 3 dBA increase in a noise level is just barely perceptible to the human ear. Typical A-weighted sound levels from transit and other common sources are shown in **Figure 1**.

Several A-weighted noise descriptors are used to determine impacts from stationary and transit related sources including the L_{max}, which represents the maximum noise level that occurs during an event such as a bus or train passby; the L_{eq}, which represents a level of constant noise with the same acoustical energy as the fluctuating noise levels observed during a given interval, such as one hour; and the L_{dn}, or the 24-hour day-night noise level, which includes a 10-decibel penalty for all nighttime activity between 10:00 p.m. and 7:00 a.m.

Figure 1: Typical A-Weighted Sound Levels

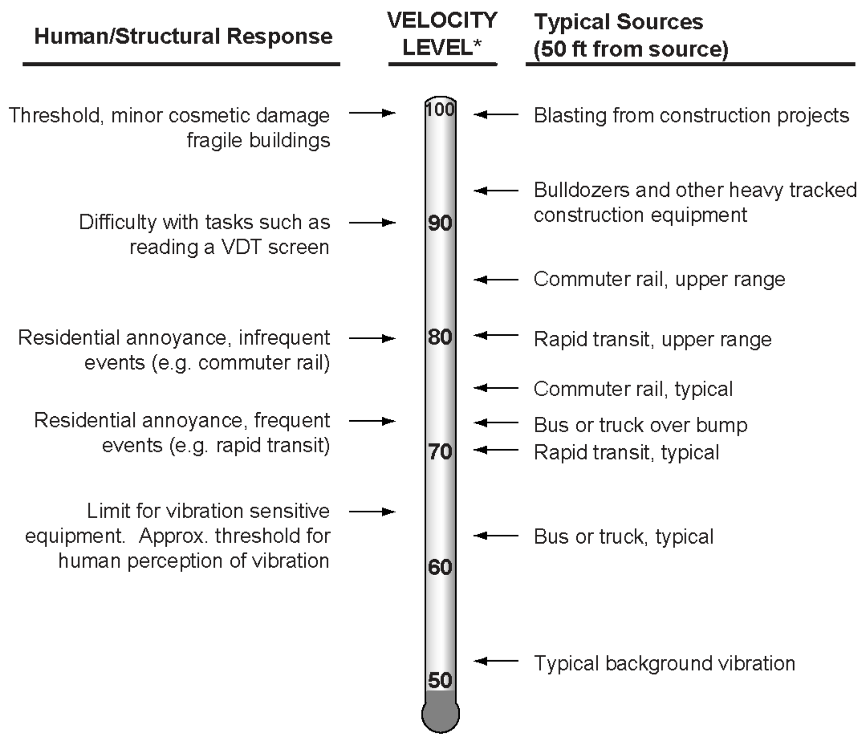


Source: Transit Noise and Vibration Impact Assessment, Federal Transit Administration, Washington, DC, May 2006.

2.2.2 Vibration

Ground-borne vibration associated with vehicle movements is usually the result of uneven interactions between wheels and the road or rail surfaces. Examples of such interactions (and subsequent vibrations) include train wheels over a jointed rail, an untrue rail car wheel with "flats," and a motor vehicle wheel hitting a pothole, a manhole cover, or any other uneven surface. Typical ground-borne vibration levels from transit and other common sources are summarized below in **Figure 2**. For example, a comparison of typical ground-borne vibration levels at a receptor 50 feet from different transportation sources traveling at 50 miles per hour ranges from 61 VdB for trucks and buses, to 73 VdB for LRT vehicles, to 85 VdB for diesel locomotives. Similarly, a typical background vibration velocity level in residential areas is usually 50 VdB or lower, well below the threshold of perception for humans, which is around 65 VdB (FTA 2006). The typical background levels refer to ambient ground vibrations not related to any specific transportation source (e.g., naturally-occurring ground vibration). This level is assumed to be fairly constant from site to site, except in the vicinity of active fault lines.

Figure 2: Typical Levels of Ground-Borne Vibration



** RMS Vibration Velocity Level in VdB relative to 10^{-6} inches/second*

Source: Transit Noise and Vibration Impact Assessment, Federal Transit Administration, Washington, DC, May 2006.

Unlike noise, which travels in air, transit vibration typically travels along the surface of the ground. Depending on the geological properties of the surrounding terrain and the type of building structure exposed to transit vibration, vibration propagation can be more or less efficient. Buildings with a solid foundation set in bedrock are “coupled” more efficiently to the surrounding ground and experience relatively higher vibration levels than buildings located in sandier soil. On the other hand, heavier buildings (such as masonry structures) are less susceptible to vibration than wood-frame buildings because they absorb more vibration energy.

Vibration induced by passing vehicles can generally be discussed in terms of displacement, velocity, or acceleration. However, human responses and responses by monitoring instruments and other objects are most accurately described with velocity. Therefore, the vibration velocity level is used to assess vibration impacts from transit projects.

To describe the human response to vibration, the average vibration amplitude (called the root mean square, or RMS, amplitude) is used to assess impacts. The RMS velocity level is expressed in inches per second or VdB. All VdB vibration levels are referenced to 1 micro-inch per second (μips). Similar to noise decibels, vibration decibels are dimensionless because they are referenced to (i.e., divided by) a standard level (such as $1x10^{-6}$ ips in the US). This convention allows compression of the scale over which vibration occurs, such as 40-100 VdB rather than 0.0001 ips to 0.1 ips.

2.2 Regulatory Framework/Evaluation Criteria

2.2.1 Federal Transit Administrations (FTA)

The operational impacts were evaluated using the guidelines set forth by the Federal Transit Administration's (FTA) *Transit Noise and Vibration Assessment*[1].

a. Operational Noise Criteria

The FTA's guidance manual Transit Noise and Vibration Impact Assessment presents the basic concepts, methods and procedures for evaluating the extent and severity of noise impacts from transit projects. Transit noise impacts are assessed based on land use categories and sensitivity to noise from transit sources under the FTA guidelines. As shown in **Figure 3**, the FTA noise impact criteria are defined by two curves that allow increasing project noise levels as existing noise increases up to a point, beyond which impact is determined based on project noise alone. The FTA land use categories and required noise metrics are shown in **Table 1**.

The FTA noise criteria are delineated into two categories: *moderate* and *severe* impact. The *moderate* impact threshold defines areas where the change in noise is noticeable but may not be sufficient to cause a strong, adverse community reaction. The *severe* impact threshold defines the noise limits above which a significant percentage of the population would be highly annoyed by new noise. The level of impact at any specific site can be established by comparing the predicted future Project noise level at the site to the existing noise level at the site. The FTA noise impact criteria for all three land use categories are shown in **Figure 3**.

Table 1: FTA Land Use Categories and Noise Metrics

Land-Use Category	Noise Metric	Description
1	$L_{eq}(h)$	Tracts of land set aside for serenity and quiet, such as outdoor amphitheaters, concert pavilions, and historic landmarks.
2	L_{dn}	Buildings used for sleeping such as residences, hospitals, hotels, and other areas where nighttime sensitivity to noise is of utmost importance.
3	$L_{eq}(h)$	Institutional land uses with primarily daytime and evening uses including schools, libraries, churches, museums, cemeteries, historic sites, and parks, and certain recreational facilities used for study or meditation.

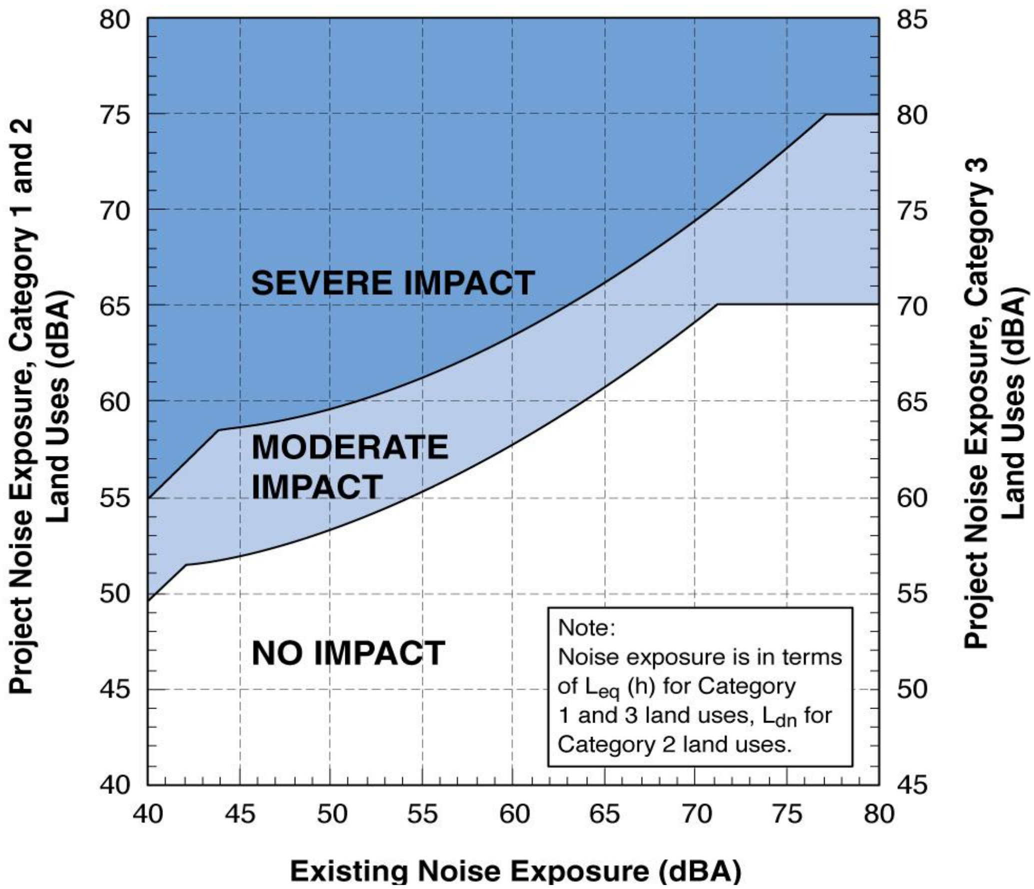
Source: "Transit Noise and Vibration Impact Assessment", Federal Transit Administration, Washington, DC, May 2006.

The average day-night noise level over a 24-hour period (or L_{dn}) is used to characterize noise exposure for residential areas (FTA Category 2). The L_{dn} descriptor describes a receiver's cumulative noise exposure from all events over a full 24 hours, with events between 10:00 pm and 7:00 am increased by 10 decibels to account for greater nighttime sensitivity to noise. For

[1] Federal Transit Administration, "Transit Noise and Vibration Impact Assessment", Washington, DC, May 2006

other noise sensitive land uses, such as schools and libraries (FTA Category 3) and outdoor amphitheaters (FTA Category 1), the average hourly equivalent noise level [or L_{eq}(h)] is used to represent the facility's peak operating period.

Figure 3: Noise Impact Criteria for Transit Projects



Source: Transit Noise and Vibration Impact Assessment", Federal Transit Administration, Washington, DC, May 2006.

b. Operational Vibration Criteria

The FTA vibration criteria for evaluating ground-borne vibration impacts from train pass-bys at nearby sensitive receptors are shown in Table 2. These vibration criteria are related to ground-borne vibration levels that are expected to result in human annoyance, and are based on RMS velocity levels expressed in VdB referenced to 1 micro inch per second (μips). The FTA's experience with community response to ground-borne vibration indicates that when there are only a few train events per day, it would take higher vibration levels to evoke the same community response that would be expected from more frequent events. This is taken into account in the FTA criteria by distinguishing between projects with frequent, occasional and infrequent events, where the frequent events category is defined as more than 70 events per day. Similarly, the occasional events category is defined as between 30 and 70 events per day while the infrequent events category is defined as less than 30 events per day. To be conservative, the FTA frequent criteria will be used to assess ground-borne vibration impacts along the project study corridor.

The vibration criteria levels shown in **Table 2** are defined in terms of human annoyance for different land use categories such as high sensitivity (Category 1), residential (Category 2), and institutional (Category 3). In general, the vibration threshold of human perceptibility is approximately 65 VdB.

Table 2: Ground-Borne Vibration (GBV) and Ground-Bourne Noise (GBN) Impact Criteria for General Assessment

Receptor Land-Use		GBV Impact Levels (VdB re 1 micro-inch/sec)			GBN Impact Levels (dBA re 20 micro Pascals)		
Category	**Description**	**Frequent Events**	**Occasional Events**	**Infrequent Events**	**Frequent Events**	**Occasional Events**	**Infrequent Events**
1	Buildings where low vibration is essential for interior operations	65	65	65	N/A	N/A	N/A
2	Residences and buildings where people normally sleep	72	75	80	35	38	43
3	Daytime institutional and office use	75	78	83	40	43	48
Specific Buildings	TV/Recording Studios/Concert Halls	65	65	65	25	25	25
	Auditoriums	72	80	80	30	38	38
	Theaters	72	80	80	35	43	43

Source: Transit Noise and Vibration Impact Assessment", Federal Transit Administration, Washington, DC, May 2006.

Additionally, the following site-specific impact criteria were also applied to assess the onset of impact at two highly-sensitive medical facilities:

- 40 VdB (100 μips) – University of Maryland Proton building (proposed)
- 50 VdB (300 μips) –National Institute of Health building (Bayview Medical Center)

For above-grade (i.e., at-grade or elevated) transit systems, the FTA ground-borne noise criteria are typically not applied, except for buildings that have sensitive interior spaces and that are well insulated from exterior noise. In general, airborne noise often masks ground-borne noise for above ground transit systems. However, the FTA ground-borne noise criteria were applied along the Cooks Lane and Downtown tunnel sections.

2.2.2 Federal and State Highway Administrations

Potential impact from traffic noise associated with the I-70 realignment was assessed on the basis of predicted design year noise levels approaching or exceeding the Federal Highway Administration's (FHWA) *Noise Abatement Criteria* (NAC). The I-70 realignment involves re-routing the roadway to accommodate the LRT corridor, which would terminate at the intersection of Cooks Lane, Forest Parkway and Security Boulevard. As shown in **Table 3**, the NAC for residences and similar sensitive exterior receivers is a one-hour equivalent sound level [L_{eq}(h)] of 67 dBA during the peak traffic hour. These noise levels are used by Maryland State Highway Administration (SHA) to evaluate the need for noise mitigation measures because of Type 1 highway improvements (i.e., physical modifications to the roadway).

Table 3: FHWA and SHA Noise Abatement Criteria (in dBA)

Activity Category	Activity Criteria[1] L_{eq}(h)[2]	Maryland SHA Approach Criteria	Evaluation Location	Activity Description
A	57	56	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B[3]	67	66	Exterior	Residential
C[3]	67	66	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, daycare centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or non- profit institutional structures, radio studios, recording studios, recreation areas, Section4(1) sites, schools, television studios, trails, and trail crossings
D	52	51	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios
E[3]	72	71	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F
F	—	—	—	Agriculture, airports, bus yards, emergency services, industrial, logging maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
G	—	—	—	Undeveloped lands that are not permitted

Notes: 1 The L_{eq}(h), or hourly equivalent A-weighted sound level, Activity Criteria values are for impact determination only, and are not design standards for noise abatement measures.
2 The equivalent steady-state sound level which in a stated period of time contains the same acoustic energy as the time-varying sound level during the same time period, with L_{eq}(h) being the hourly value of L_{eq}.
3 Includes undeveloped lands permitted for this activity category.

Source: State Highway Administration, Highway Noise Policy, Maryland Department of Transportation, Baltimore, MD, April 13, 2011, effective: July 13, 2011.

The SHA *Highway Noise Policy*[2] has defined "approaching" as within one decibel of the FHWA NAC for residential or other similar sensitive land use areas. Additionally, SHA also defines as impact project noise levels that are anticipated to "substantial increase" over existing noise by 10-15 dBA.

FHWA guidelines and the SHA *Highway Noise Policy* indicate that abatement should be considered if the noise criteria described above meet or exceed. However, the abatement measures must be both "feasible" and "reasonable" to be recommended for implementation.

According to the SHA *Highway Noise Policy*, feasibility refers to engineering considerations (e.g., can a barrier be built given the topography of the location; can a substantial noise reduction be achieved given certain access, drainage, safety, or maintenance requirements; are other noise sources present in the area, etc.). For instance, maintaining access to commercial properties often requires gaps in barriers at entrance and exit driveways that reduces the barrier's effectiveness to the point that substantial noise reduction is not feasible. Acoustic considerations include a modeled reduction of projected noise levels by at least 5 dBA at 50 percent of the sites where exceedances are predicted.

Reasonableness of noise barriers include cost/benefit, maintainability and land use conformity considerations. Although reasonableness is generally a more subjective criterion (which implies that common sense and good judgment were applied in arriving at a decision), barrier cost must also be considered. For example, according to SHA's square foot averaging method, a barrier system would be considered reasonable if the area of wall provided per benefited residence is equal to, or less than, 2,700 square feet. This measure would be used if necessary as part of the reasonableness cost analysis. SHA includes only benefited receptors whose barrier insertion loss is 5 dBA or greater (for both impacted and non-impacted receptors). Additionally, SHA's Noise Reduction Design Goal states that at least 50 percent of benefited residences must also receive at least a 7 dBA reduction from the proposed abatement in order for the abatement to be considered reasonable.

2.2.3 Construction Criteria

During the environmental analysis phase of a project, construction details are limited. Therefore, the FTA guidelines suggest evaluating prototypical construction scenarios against local ordinances if applicable criteria are available. The FTA design guidelines, for example, are evaluated against noise levels from the two loudest pieces of equipment that, under worst case

[2] State Highway Administration, *Highway Noise Policy*, Maryland Department of Transportation, Baltimore, MD, April 13, 2011, effective: July 13, 2011.

conditions, are assumed to operate continuously for one hour during both the daytime (7 AM to 10 PM) and nighttime (10 PM to 7 AM) periods.

The following local noise ordinances were identified for the project study corridor:

- Baltimore City – Construction activities are exempt from the City's noise code (Health Code of Baltimore City, § 9-103.b Noise Regulation).
- Baltimore County – No noise limits are set by the County for construction (Baltimore County Code 17.03. Noise).
- The county's noise policy is for nuisance noise only.

However, since neither of the local noise ordinances provides quantitative noise limits on construction activities, the noise policy from the Maryland Department of the Environment (MDE) was used to assess temporary construction activities.

a. Noise – Maryland Department of the Environment

The Maryland Department of the Environment (MDE) has established the following noise guidelines for construction activities. These maximum allowable sound pressure levels, although not specified, are assumed to be L_{max} levels:

- Construction activities are regulated by MDE 26.02.03 Control of Noise Pollution:
- 90 dBA – daytime (7:00 am – 10:00 pm) – residences
- 55 dBA – nighttime (10:00 pm – 7:00 am) – residences
- Blasting during construction is exempt from the MDE noise ordinance during the daytime (7:00 am – 10:00 pm);
- Pile driving during construction is exempt from the MDE noise ordinance from 8:00 AM – 5:00 pm; and,
- Construction activities on public property are exempt (MDE 26.02.03.03.b.2.L).

b. Vibration – FTA.

The vibration levels shown in **Table 2** are used to evaluate potential FTA vibration annoyance impacts from various construction scenarios expected along the project corridor. The potential for annoyance from the proposed construction scenarios will be evaluated at sensitive receptors along the project study corridor. These proposed construction scenarios, however, include primarily surface-related activities and are, therefore, unlikely to cause even minor structural damage, such as small cracks in plaster walls.

However, for tunneling activities, pile driving and blasting activities, the FTA damage criteria shown in **Table 4** were used to assess the potential for cosmetic damage.

Table 4: FTA Construction Vibration Damage Criteria

Building Category		PPV (in/sec)	Approximate Equivalent RMS (VdB)[1]
I	Reinforced-concrete, steel or timber (no plaster)	0.5	102
II	Engineered concrete and masonry (no plaster)	0.3	98
III	Non-engineered timber and masonry buildings	0.2	94
IV	Buildings extremely susceptible to vibration damage	0.12	90

Note 1: RMS velocity in decibels (VdB) re: 1 micro-inch per second

2.3 Area of Potential Effect

In accordance with the FTA Transit Noise and Vibration Impact Assessment guidelines (FTA 2006), a screening assessment was conducted to determine the location and number of noise- and vibration-sensitive receptors along the project corridor. The FTA screening distances for operations are based on typical LRT systems and were adjusted to reflect project-specific conditions. The following FTA screening distances were utilized to develop the population of receptors included in the noise and vibration modeling analyses:

- 350 feet – unobstructed noise screening distance
- 150 feet – unobstructed vibration screening distance

The screening distances were applied from the centerline of the proposed transit corridor to determine the area of potential effect (APE).

The APE for construction activities varies, depending on factors such as types and numbers of construction equipment operating in an area at the same time, and the specific location and distance between the construction activity and the sensitive receptor. As mentioned, the specific types and locations of equipment in any one location are difficult to predict at this early stage of project development. Therefore, the same APE used to assess operational impacts was also used to assess the potential for construction impacts. Nevertheless, it is acknowledged that there would be some impacts and the discussion in **Section 6** provides strategies to reduce these effects.

2.4 Analysis Methodology and Assumptions

Noise impacts were evaluated using the FTA's "Detailed Assessment" guidelines to more accurately reflect the type of input data available. However, noise impacts from stationary sources (such as the maintenance yard) were evaluated using the FTA's "General Assessment" guidelines to reflect a single large stationary source (FTA 2006). Similarly, although baseline vibration measurements were conducted, operational vibration impacts were evaluated using the FTA's "General Assessment" guidelines to reflect average or typical ground conditions. A detailed and refined vibration monitoring program may be necessary during Final Design to verify (or dismiss) any impacts that were predicted using the default FTA guidelines.

Where exceedances of the project impact criteria are predicted, mitigation measures were developed and evaluated to determine whether they are both “feasible” (able to provide adequate noise reduction benefits) and “reasonable” (mitigation is cost-effective based on the benefit provided). The Maryland SHA *Highway Noise Policy* was used to evaluate the effectiveness of mitigation measures such as noise barriers. For example, to be feasible, a noise barrier must provide a minimum 5-decibel noise reduction for at least 50 percent of the impacted receptors. Similarly, the noise barrier system would be considered reasonable if the area of wall provided per benefited residence is equal to, or less than, 2,700 square feet.

2.4.1 Noise Operating Assumptions

The reference noise levels for each of the proposed noise sources (including train pass-bys, warning bells, wheel squeal) and other operating characteristics (such as average dwell times and source heights) are summarized in **Table 5**. These data are based on default FTA data as well as information included in project design criteria (“DRAFT Advanced Vehicle Design Part 1: Rail Vehicle Design Criteria Advanced Conceptual Design”, August 2010). These data do not reflect modeling assumptions utilized for the Purple Line Corridor.

Total daily operations were determined based on 7-minute headways during peak periods of the day, 10-minute headways during off-peak periods, and 15-minute headways during the late night and early morning periods.

This service frequency was used to predict future noise levels under the Preferred Alternative.

The LRT operations data are summarized in **Table 6** for various peak and off-peak periods of the day. This service frequency is representative of a typical weekday, which includes an operating period between 5:00 AM and 1:00 AM.

A two-vehicle train consist was assumed for all periods of the day and night.

At stations, an average idling time of 20 seconds was used at each of the designated stations to compute the noise contribution from stationary or auxiliary vehicle noise (such as rooftop mechanical equipment).

Proposed train operating speeds were taken from speed profiles provided by the project team, based on vehicle performance characteristics and system speed limits for the project corridor, with a maximum speed of 55 miles per hour (mph).

Following MTA operating practices, onboard warning devices or bells would be sounded within five seconds of the approaching grade crossing, with a maximum noise level of 80 dBA at 50 feet. Depending on the actual train speed, the distance within which the warning bells would be sounded ranges from 100 feet at 15 mph to 400 feet at 55 mph. This distance is less than the FRA-required distance of one quarter mile or 1,320 feet from any approaching grade crossing.

At all grade crossings with flashers and gates, stationary crossing bells would also ring approximately 5 seconds while the gates arms are lowered. There are currently no grade crossings with traffic or pedestrian controls where crossing bells are not proposed.

Similarly, in accordance with current MTA procedures, onboard warning bells would also be sounded approximately 5 seconds as trains approach the station. At an average speed of approximately 30 mph, the warning bells would be sounded within a distance of 200 feet.

Table 5: Summary of Noise Source Reference Data

Noise Source Category	Name	Description	Duration (sec)	Height (ft)	Noise Level (dBA)[1] L_{max}	Noise Level (dBA)[1] SEL
LRT	Passbys	Passby Operations	--[2]	2	77[3]	79
	Warning Device	Onboard Bell	5[4]	10	80[3]	83[3]
	Switches/ Crossovers	Special Track Work	--	0	82	84
	Wheel Squeal	Curves <65 feet	4	0	78[3]	114
	Auxiliary Equipment	Stations only	20[5]	10	65	101
Crossing Bell	Grade Crossing Bell	Grade Crossing	15[3]	2	73[6]	109
Yard	Maintenance Yard	Yard	--	2	82	118
Ancillary Equipment	Substation (TPSS)	Transformer	continuous	5	63	99
	Fan Plant	Tunnel Ventilation	continuous	50	55	91
	Parking	Park-and-Ride Lot	--	2	65	101

Notes: 1 All A-weighted noise levels are reported in decibels at a reference distance of 50 feet and a reference speed of 50 mph for passbys only. L_{max} represents the maximum noise level during an event and SEL is the sound exposure level that converts the cumulative noise energy of an event to one second. Default FTA reference levels are reported except where noted.

2 "--" means not applicable. Duration time is not a used to compute passby and facility noise levels.

3 Reference noise levels are based on the MTA Design Criteria [*Draft: Advanced Vehicle Design, Part 1: Rail Vehicle Design Criteria, Advanced Conceptual Design*, 4.15 Noise Levels, August 2010].

4 Duration times are based on feedback from the project design team, May 11, 2012.

5 The default dwell time is 20 seconds at all proposed stations [*Draft: Advanced Vehicle Design, Part 1: Rail Vehicle Design Criteria, Advanced Conceptual Design*, 4.11 Duty Cycle, August 2010].

6 The L_{max} level for the crossing bell reflects a 5-dBA penalty to account for the intrusive character of the noise source.

Source: MTA, May 2012.

Based on information included in the Project Design Criteria, a single LRT train operating at 50 mph on ballast-and-tie track with continuous welded rail track generates a maximum noise level of 77 dBA at 50 feet from the track centerline.

Wheel impacts at switches and other special track work are based on a maximum default noise level of 82 dBA at 50 feet, which reflect an FTA-adjustment of 5 dBA above the maximum LRT passby level.

Since all of the curves along revenue-service track are expected to have a radius greater than 82 feet, no wheel squeal is predicted anywhere along the project study corridor based on LRT vehicles capable of navigating curves down to 65 feet. Although there is a possibility of wheel squeal at the maintenance yards because of the shorter-radius curves, these events are expected to occur infrequently; therefore, no adverse impacts are expected.

In lieu of a solid transit barrier or parapet, open railings with no acoustical properties were used as part of the noise modeling analysis for all elevated or aerial sections of the proposed alternatives. However, the edge of the aerial structure (which is a solid footing for the railing and has an approximate height of six inches) was included in the noise modeling analysis to provide some acoustical benefits.

Table 6: LRT Alternative Operating Characteristics in Design Year of 2035

Time Period	Hours	Frequency of Service[1]	Consist Size[2]
Early Morning	5:00 to 6:00 AM	15	2
AM Peak	6:00 to 9:00 AM	7	2
Midday	9:00 AM to 3:30 PM	10	2
PM Peak	3:30 to 6:30 PM	7	2
Early Evening	6:30 to 9:00 PM	10	2
Late Evening	9:00 PM to 1:00 AM	15	2

Notes: 1 The frequency of service (or headway time) is reported in minutes.
2 Consist size is the number of LRT vehicles coupled together into one train.
Source: MTA, May 2012.

Although “green track” is being considered along embedded sections of track, the acoustical benefits of such products have not been applied to the noise or vibration modeling analysis.

Vehicular noise from the proposed park-and-ride surface lots was also included in the modeling analysis using the FTA "General Assessment" guidelines.

Noise from feeder buses at stations was evaluated to account for idling from both through routes and layover routes. However, feeder buses currently operating along the project corridor would continue to do so with only minor modifications. As a result, no new noise is proposed as a result of feeder bus operations.

Additionally, the MTA is expected to replace louder diesel buses with electric-hybrid buses, which are approximately 7-10 dBA lower than diesel buses.

The default FTA reference L_{max} level of 82 dBA was applied for the Operations and Maintenance Facility, which includes rooftop ventilation fans, mechanical equipment inside the facility, vehicle movements and other general activities.

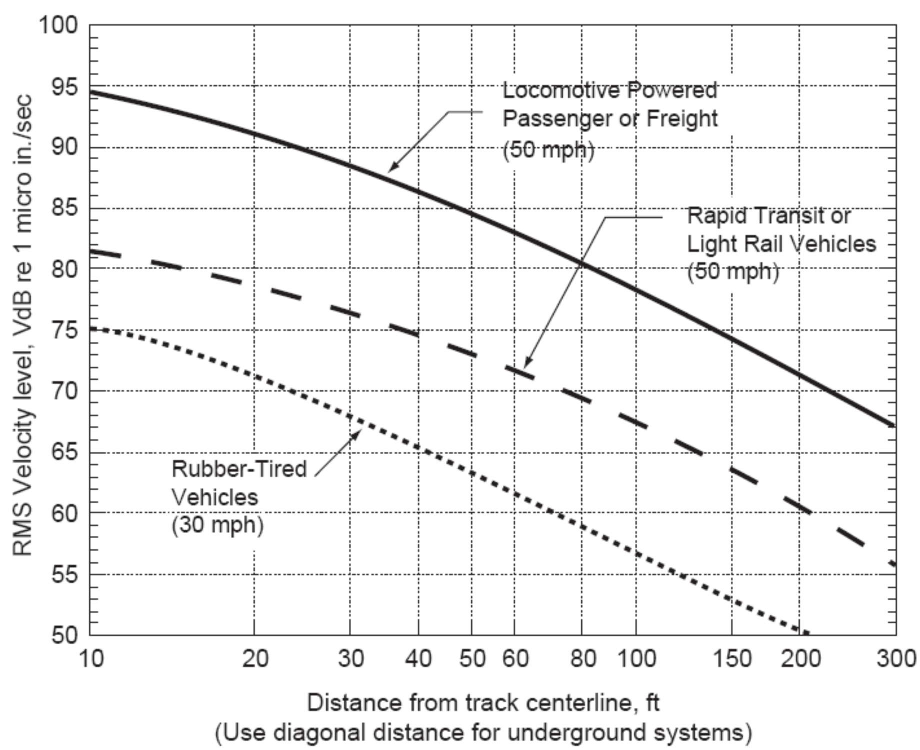
The overall noise levels from ventilation fans and other mechanical equipment at the fan plants are based on similar ventilation buildings evaluated recently as part of the Region’s Core (ARC) Tunnel Project. Depending on the sensitivity of the surrounding land-uses, tunnel fan plants are typically designed with attenuators, acoustical louvers and other control technologies to mitigate noise impacts at nearby noise-sensitive receptors.

Finally, Type 1 highway traffic noise levels because of the re-alignment of I-70 were also evaluated using the Federal Highway Administration's (FHWA) Traffic Noise Model (TNM), Version 2.5. Peak-hour traffic volumes and vehicle mix was used to estimate future L_{eq} noise levels from the re-located highway. Additional details are included in a separate report, "Traffic Noise Impacts from the I-70 Re-alignment". Maximum free flow speeds of 30, 45 and 60 mph were used along the re-aligned sections of I-70.

2.4.2 Vibration Operating Assumptions

Future ground-borne vibration levels from LRT pass-bys were predicted using the default FTA ground surface vibration curves shown in **Figure 4**. These curves were adjusted to reflect local conditions such as changes in train speed, special track work such as switches, aerial track structures and different receptor building construction types (masonry versus timber).

Figure 4: FTA Generalized Ground Surface Vibration Curves



Source: "Transit Noise and Vibration Impact Assessment", Federal Transit Administration, Washington, DC, May 2006.

2.4.3 Construction

The FTA guidelines were used to develop a preliminary assessment of the potential for temporary construction noise and vibration impacts. Depending on the level of detail available during the early stages of the project, both a General and a Detailed Assessment was conducted.

The FTA General Assessment was conducted if the equipment roster and schedule are undefined and only a rough estimate of construction noise levels is practical; or,

The FTA Detailed Assessment was conducted if construction equipment types and operating scenarios have been defined with sufficient detail for planning purposes to more accurately assess the potential for impact at nearby noise-sensitive receptors.

Unlike the General Assessment, which includes selecting the two loudest pieces of equipment (such as pile drivers and rock drills) to estimate the level of impact, the Detailed Assessment incorporated individual equipment types and operating characteristics for various constructions scenarios. The resultant noise levels were compared with the MDE noise limits to determine the potential for impact. Similarly, the equipment with the highest vibration level for the proposed construction was also selected to estimate the level of impact at the closest vibration-sensitive receptors.

Based on equipment usage provided by the project team for each construction scenario, the construction noise and vibration analysis was prepared in accordance with the FTA guidelines. The future temporary cumulative noise and maximum vibration levels from each scenario was based on the types of equipment proposed, their distances to nearby receptors, their usage factors (or the percentage of time the equipment is operated at maximum power) and the duration of usage for each work shift. The intent of the construction analysis during the environmental phase is to identify the potential for impact, and to provide applicable mitigation measures that the contractor would be required to follow in order to achieve compliance with the local and State noise and vibration ordinances.

Although several construction scenarios are proposed as part of the project, only those scenarios that are expected to result in worst-case noise and vibration levels in the community were evaluated as part of this preliminary construction analysis. As a result, the following construction scenarios were evaluated as part of a detailed noise and vibration analysis:

- Track Laying, At-grade
- Tunnel Boring and Excavation
- Station Construction, At-grade
- Station Construction, Below-grade
- Fan Plant (Ancillary Station) Construction; and,
- Operations and Maintenance Facility.

During the preliminary FEIS phase of the project, worst-case operating conditions were assumed for all construction activities. For example, continuous construction activities (24 hours per day, 7 days per week) were assumed for all construction scenarios.

a. Construction Noise Assumptions.

A quantitative analysis was prepared to estimate the potential for noise impacts during temporary construction activities. Based on the FTA guidelines, the cumulative noise level at the closest noise-sensitive receptors was used to estimate the level of impact. The resultant L_{max} noise level was compared with the MDE noise limits of 90 dBA (daytime) and 55 dBA (nighttime) to determine the onset of impact. Conservative assumptions (such as no shielding effects from existing structures or no temporary noise barriers) were utilized to estimate the potential for impact.

b. Construction Vibration Assumptions

Using the same equipment types and scenarios included in the noise analysis, a quantitative analysis was also prepared to estimate the potential for vibration impacts during temporary construction activities. Based on the FTA guidelines, the maximum vibration level at the closest vibration-sensitive receptor was used to estimate the level of impact. The resultant vibration level was compared with the FTA Ground-Borne RMS Vibration Impact Criteria for Annoyance from **Table 2** to determine the onset of impact. Conservative assumptions (such as normal or typical ground propagation effects) were utilized to estimate the potential for impact.

3. Existing Conditions

A noise and vibration monitoring program was conducted to document existing conditions at sensitive receptors along the project corridor.

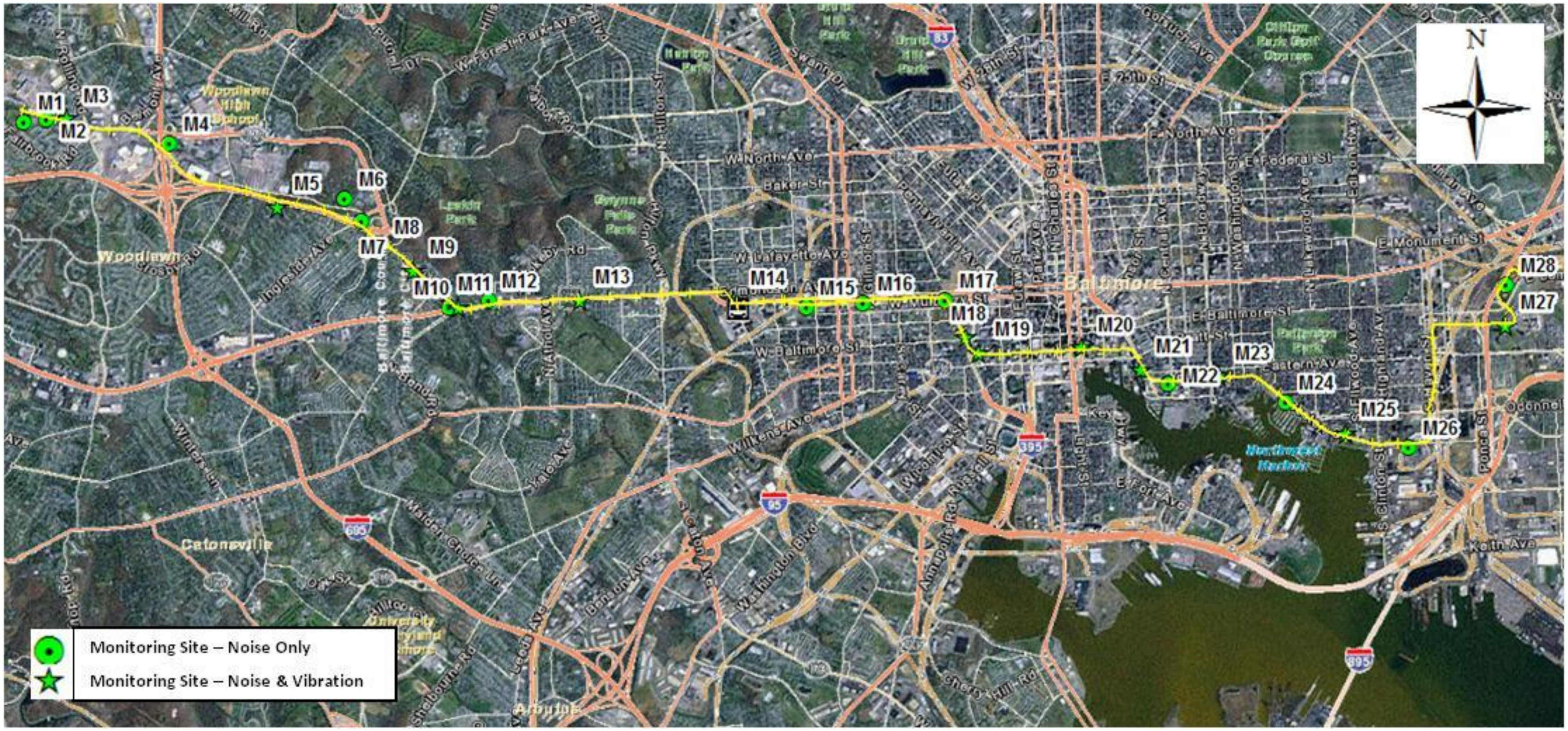
3.1 Noise

To determine the existing background noise levels at sensitive receptors in the vicinity of the proposed transit rail corridor, a noise-monitoring program was conducted at 28 representative locations shown in **Figure 5** and described in **Table 7**. Noise levels were measured at various periods of the day in accordance with the FTA guidelines to determine the average ambient conditions during a typical weekday. Because of the number of monitoring sites, these measurements were started on December 12-16, 2011 and completed on February 6-10, 2012.

The noise measurements documented existing noise sources along the project study corridor such as existing traffic along Interstate 695 (I-695), Edmondson Avenue, Lombard Street, Boston Street and other major cross streets. The 24-hour day-night noise level (or L_{dn}) is used to describe existing noise at residences and other FTA Category 2 land-uses. Similarly, peak-hour equivalent noise levels (L_{eq}) are reported for non-residential or institutional receptors such as schools, libraries or churches. All noise levels are reported in A-weighted noise levels (or dBA) for comparison with the FTA criteria. A detailed description of the noise monitoring program is included in the "Noise and Vibration Monitoring Protocol" (October 4, 2011, Revision 0).

As summarized below in **Table 7**, the measured day-night noise levels along the project study corridor range from 54 dBA at Receptor M08 (residences along Stamford Road in Edmondson Park) to 79 dBA at Receptor M20 (mixed-use properties along Lombard Street in Downtown). In general, the lower noise levels represent suburban locations while the higher noise levels reflect heavy traffic along downtown urban streets.

Similarly, measured peak-hour noise levels at institutional receptors along the project study corridor range from 58 dBA at Receptor M01 (Chadwick Elementary School on Winder Road in Chadwick Manor) to 69 dBA at Receptors M10 (St. William of York Church and School on Cooks Lane in Hunting Ridge) and M19 (University of Maryland Medical School on Lombard Street in Downtown). These levels are representative of active urban land-uses.



Source: AECOM, May 2012.

Figure 5: Noise and Vibration Monitoring Sites along the Red Line Project Study Corridor

Table 7: Baseline Noise Monitoring Results

ID	Receptor Description	Neighborhood[1]	Land-Use	FTA	Pk-Hr (L_{eq})	24-Hr (L_{dn})
M01	Chadwick Elementary, Winder Rd	Chadwick Manor	SCH	3	58	--
M02	Winder Rd at Calais Ct	Chadwick Manor	RES	2	58	58
M03	Security Blvd	Chadwick Manor	RES	2	59	61
M04	Days Inn, Whitehead Ct	Woodlawn	MOT	2	60	71
M05	Baltimore St at I-70	Brigadoon	RES	2	61	64
M06	Calvert Rd	Franklintown	RES	2	58	59
M07	Ingleside Ave at I-70	Ingleside Park	RES	2	69	70
M08	Kirkwood Rd at Forest Park Ave	Edmondson Park	RES	2	50	54
M09	Cooks Ln	Wedgewood	RES	2	72	69
M10	St. William of York Church/ School, Cooks Ln	Hunting Ridge	CHU	3	69	--
M11	Edmondson Ave at Cooks Ln	Hunting Ridge	RES	2	71	74
M12	Edmondson Ave at Glen Allen Dr	Hunting Ridge	RES	2	50	54
M13	Edmondson Ave at Cathedral Cemetery	Rognel Heights	RES	2	73	69
M14	W. Franklin St at Franklintown Rd	Western	RES	2	72	77
M15	W. Mulberry St at Smallwood St	Harlem Park	RES	2	73	73
M16	W. Mulberry St. at N. Gilmore St	Harlem Park	RES	2	74	68
M17	W. Mulberry St at Fremont Ave	Harlem Park	RES	2	63	65
M18	N. Fremont Ave at Baltimore St	Poppleton	RES	2	71	74
M19	University of Maryland Medical School, W. Lombard St	Downtown West	SCH	3	69	--
M20	W. Lombard St at Calvert St	Downtown East	RES	2	74	79
M21	President St. at Eastern Avenue	Little Italy	RES	2	69	68
M22	Fleet St at Central Ave	Little Italy	RES	2	65	66
M23	Fleet St at Broadway	Upper Fell's Point	RES	2	69	72
M24	Boston St at Montford Ave	Canton Park	RES	2	62	65
M25	Boston St at Potomac St	Canton Park	RES	2	73	69
M26	Boston St at Conklin St	Canton Park	RES	2	64	67
M27	Alpha Commons Dr	Bayview	RES	2	65	67
M28	E. Lombard St	Bayview	MED	3	66	71

Notes: 1 The neighborhood data was provided by www.livebaltimore.com.
2 Land use types include single- or multi-family residences (RES), schools (SCH), churches (CHU) medical facilities (MED) and motels (MOT).
Source: MTA, May 2012.

In general, the project study corridor generally consists of dense residential and a mix of residential-commercial communities along highways and urban arterials (I-70, Edmondson Avenue, Mulberry Street, Lombard Street, etc.). Based on the monitoring results, the high ambient noise conditions noted in **Table 7** reflect the proximity of residences to active transportation corridors.

3.2 Vibration

Similar to noise, a vibration-monitoring program was conducted on February 6-10, 2012 at 14 representative locations shown in **Figure 5** including Sites M03, M05, M08, M09, M11, M13, M14, M18-21, M23, M25 and M27. Unlike noise, however, vibration is event based rather than a cumulative exposure over a period of time. Therefore, existing vibration measurements documented existing vehicular traffic along local streets and arterials in the vicinity of the identified receptors. Average vibration levels from existing transportation sources at all sites ranged from 0.01 ips for car passbys to 0.05 ips for truck passbys.

Additionally, vibration measurements were also conducted at the National Institute of Health (NIH) facility at the Johns Hopkins Bayview Medical Center campus on May 7-9, 2012. These detailed measurements are intended to document the ground propagation characteristics between the proposed Red Line rail corridor and the façade of the building. These measurements also document the seismic response of the building itself as well as the sensitive laboratory equipment including electron microscopes and magnetic resonance Imaging (MRI) machines. Because of the sensitivity of this equipment, a low vibration threshold of 300-400 micro-inches per second (μips) is proposed for the Red Line construction and operations.

4. Future No-Build Conditions

4.1 Noise

Future noise levels under the No-Build Alternative are anticipated to be similar to those under existing conditions. The project study corridor is characterized by urban communities that include major highways (such as I-70 and US 40) and arterials (such as Lombard Street and Edmondson Avenue). Irrespective of other projects in the Long Range Transportation Plan, ambient noise under the No-Build Condition is anticipated to be essentially the same as under existing condition without the Preferred Alternative. For example, it takes a doubling of the traffic volumes for the noise levels to increase by 3 dBA, the threshold where most listeners detect the change. However, increases in traffic levels of less than 40 percent in the project study corridor between now and 2035 are expected to result in higher congestion and lower average travel speeds. Therefore, no significant noise impacts are expected under the No-Build Condition.

4.2 Vibration

Future vibration levels under the No-Build Condition are expected to be similar to those currently experienced under existing conditions. Traffic, including heavy trucks and buses, rarely creates perceptible ground-borne vibration unless vehicles are operating very close to buildings or there are irregularities in the road, such as potholes or expansion joints. The pneumatic tires and suspension systems of automobiles, trucks, and buses eliminate most ground-borne vibration. Since no project elements are proposed under the No-Build Condition, the alternative would not cause any vibration impacts.

5. Preferred Alternative

Along the Preferred Alternative, LRT service is proposed from the Centers for Medicare & Medicaid (CMS) in Woodlawn to the Johns Hopkins Bayview Medical Center campus, and would generally follow a west-to-east flow along Edmondson Avenue, Lombard Street and Boston Street. The Preferred Alternative is proposed along new sections of track that would generally be located along the median of existing surface streets.

5.1 Long-Term Operational Effects and Mitigation

5.1.1 Operational Noise Impacts

At residences and other FTA Category 2 land uses such as motels and hospitals sensitive to nighttime activity, the L_{dn} descriptor was used to reflect the particularly heightened sensitivity to nighttime noise. To see the change in noise levels from the existing condition, the predicted future noise levels from operations with the Preferred Alternative are summarized below in **Table 8** for the same receptor locations used to monitor current noise levels (see **Figure 5**). As summarized in **Table 8**, the L_{dn} day-night noise levels at residences along the proposed alignment are predicted to range from well below background (or 10-15 dBA below the existing level) along the Cooks Lane and Downtown Tunnel areas to 66 dBA at Site M14 (residences along West Franklin Street). At the selected representative receptors, the noise level at Sites M14, M15 and M26 is predicted to exceed the FTA *moderate* impact criteria.

Table 8: Predicted Noise Levels at Representative Receptors from the Preferred Alternative (in dBA)

Receptor		Land Use		Noise	Existing	Build	FTA Criteria		Total
ID	Description	Type[1]	FTA	Metric	Noise	Noise	"MOD"	"SEV"	Noise
M01	Chadwick Elementary, Winder Rd	SCH	3	L_{eq}	58	44	62	67	58
M02	Winder Rd at Calais Ct	RES	2	L_{dn}	58	54	57	62	59
M03	Security Blvd	RES	2	L_{dn}	61	56	58	64	62
M04	Days Inn, Whitehead Ct	MOT	2	L_{dn}	71	55	65	70	71
M05	Baltimore St at I-70	RES	2	L_{dn}	64	50	60	66	64
M06	Calvert Rd	RES	2	L_{dn}	59	44	57	63	59
M07	Ingleside Ave at I-70	RES	2	L_{dn}	70	53	64	70	70
M08	1217 Stamford Rd	RES	2	L_{dn}	54	31	55	61	54
M09	Cooks Ln	RES	2	L_{dn}	69	25	64	69	69
M10	St. William of York Church/School, Cooks Ln	CHU	3	L_{eq}	71	26	69	74	69
M11	Edmondson Ave at Cooks Ln	RES	2	L_{dn}	74	27	65	72	74
M12	Edmondson Ave at Glen Allen Dr	RES	2	L_{dn}	50	32	58	65	50
M13	Edmondson Ave at Cathedral Cemetery	RES	2	L_{dn}	73	58	70	77	73
M14	W. Franklin St at	RES	2	L_{dn}	77	**66**	65	75	77

Table 8: Predicted Noise Levels at Representative Receptors from the Preferred Alternative (in dBA)

Receptor		Land Use		Noise	Existing	Build	FTA Criteria		Total
ID	Description	Type[1]	FTA	Metric	Noise	Noise	"MOD"	"SEV"	Noise
	Franklintown Rd								
M15	W. Mulberry St at Smallwood St	RES	2	L_{dn}	73	**65**	65	72	74
M16	W. Mulberry St. at N. Gilmore St	RES	2	L_{dn}	68	56	63	68	68
M17	W. Mulberry St at Fremont Ave	RES	2	L_{dn}	65	41	61	66	65
M18	N. Fremont Ave at Baltimore St	RES	2	L_{dn}	71	43	70	75	71
M19	University of Maryland Medical School, W. Lombard St	SCH	3	L_{eq}	69	42	69	74	69
M20	W. Lombard St at Calvert St	RES	2	L_{dn}	79	37	65	75	79
M21	President St. at Eastern Avenue	RES	2	L_{dn}	69	38	69	74	69
M22	Fleet St at Central Ave	RES	2	L_{dn}	69	37	66	71	65
M23	Fleet St at Broadway	RES	2	L_{dn}	72	39	65	71	72
M24	Boston St at Montford Ave	RES	2	L_{dn}	65	46	61	66	65
M25	Boston St at Potomac St	RES	2	L_{dn}	69	62	64	69	70
M26	Boston St at Conklin St	RES	2	L_{dn}	67	**63**	62	68	69
M27	Alpha Commons Dr	RES	2	L_{dn}	67	59	62	68	68
M28	E. Lombard St	MED	3	L_{eq}	66	51	67	72	66

1 FTA *moderate* (MOD) impacts are bold and shaded for clarity. No *severe* (SEV) impacts are shown.
2 Land use types include single- or multi-family residences (RES), schools (SCH), churches (CHU), medical facilities (MED) and motels (MOT).
Source: MTA, September 2012.

The "Build Noise" levels represent the future project noise only under the Preferred Alternative. It is the "Build Noise" that is used to assess the onset of impact from the project. The "Total Noise", which represents the cumulative or total future ambient noise with the project, is provided for disclosure purposes only.

Noise impacts at the selected noise monitoring locations described above were used to characterize noise impacts from the Preferred Alternative at over 1,500 receptors along the Preferred Alternative. As a result of this evaluation, corridor-wide project noise exposure levels along the Preferred Alternative are predicted to exceed the FTA *moderate* impact criteria at 96 residences and the FTA *severe* impact criteria at one residence (The Shipyard condominium building at the corner of Boston Street and Lakewood Avenue). None of the project noise levels along the Preferred Alternative are predicted to exceed the FTA impact criteria at any FTA

Category 3 receptors. Although several of the noise impacts are because of LRT passbys and LRT warning bell usage, the majority of the noise impacts are primarily due LRT warning bells and grade crossing bells. The predicted corridor-wide noise impacts are summarized in **Table 9** and shown graphically in **Appendix A**.

Table 9: Corridor-wide Project Noise Impacts under the Preferred Alternative

ID[1]	Location	Type Use[2]	Impact (Moderate or Severe)	No. Residences Affected[3]	Major Source(s) Contributing to Impact[4]
FTA Category 2					
1	West	RES	Severe Moderate Total	0 3 3	LRT passbys & warning bells
2	Cooks Lane	RES	Severe Moderate Total	0 1 1	LRT passbys & warning bells
3	US 40	RES	Severe Moderate Total	0 87 87	LRT passbys & warning bells
4	Downtown Tunnel	RES	Severe Moderate Total	0 0 0	None
5	East	RES	Severe Moderate Total	1 5 6	LRT passbys & warning bells
	Total – All Uses		**Severe** **Moderate** **Total**	**1** **96** **97**	

Notes: 1 ID corresponds to general location as shown in Appendix B.
2 RES includes both Single-Family Residences (SFR) and Multi-Family Residences (MFR).
3 The number of affected residences is shown for the Preferred Alternative.
4 Major sources include LRT passbys, LRT warning bells, and switches or special track work. The operations and maintenance facility and TPSS are not expected to be a primary source for impacts in any noise-sensitive locations.
Source: MTA, September 2012.

5.1.2 Noise Impacts from LRT Vehicle Pass-bys

Maximum passby noise levels from LRT vehicles (shown in **Table 5**) were used to develop cumulative day-night noise levels over a 24-hour period using typical weekday operating conditions. Unlike the L_{eq} and L_{dn} noise metrics (which are statistically derived), the L_{max} noise level is the sound that people actually hear during a noise event. For example, maximum noise levels along the Preferred Alternative from LRT train passbys are predicted to range from 58 dBA at Site M6 (residences along Calvert Road) to 74 dBA at Site M26 (residences along Boston Street). Except in the vicinity of grade crossings, where onboard warning bells are used, the dominant noise sources from LRT passbys along the proposed transit corridors would be wheel-rail and aerodynamic noise.

5.1.3 Noise Impacts from Special Track Work

Special track work (such as turnouts and crossovers) is proposed at several locations along the Preferred Alternative to provide operational flexibility. Turnouts or switches allow trains to move from one track to another, while crossovers allow trains to move between parallel tracks. Noise from switches or crossovers comes from a small gap in the central part of the switch known as a frog. When the steel LRT wheel hits this gap, train noise levels could increase up to 5 dBA similar to jointed-rail track.

Maximum noise levels from switches are predicted to range from 40 dBA at Site M25 (residences along Boston Street) to 70 dBA at Site M14 (residences along West Franklin Street). However, because switches were strategically located to avoid impacts, switches are not predicted to contribute to exceedances of the FTA impact criteria anywhere along the project corridor except at the maintenance facility. Maximum noise levels between 80-81 dBA from switches are predicted at residences opposite the proposed maintenance facility (residences along West Franklin Street).

5.1.4 Noise Impacts from Traction Power Substations (TPSS)

The TPSS are transformers that “step-up” the voltage necessary to operate the trains. Although these box-like devices do not have any gears, belts or other moving mechanical parts, TPSS noise is a continuous hum. Transformer noise is caused by the constant expansion and contraction of the magnetically charged metal plates inside the casing.

As part of the Preferred Alternative, TPSS would be installed at several locations along the project study corridor to provide adequate electrical power for LRT service. Each TPSS would be designed in accordance with the MTA’s system-wide design criteria to minimize noise impacts in the community. For example, maximum noise levels from TPSS are predicted to range from well below background to a maximum of 59 dBA at Site M14 (residences along West Franklin Street). As a result, no exceedances of the FTA noise impact criteria because of the TPSS are predicted at any receptors along the Preferred Alternative.

5.1.5 Noise Impacts from the Operations and Maintenance Facility

An Operations and Maintenance Facility is proposed along the south side of US 40/West Franklin Street centered on Calverton Road between Franklintown Road and Warwick Avenue. The proposed maintenance yard would accommodate daily maintenance, inspection and repairs, and storage of the LRT vehicles. Additionally, although no tight curves with a radius less than 100 feet is proposed along the Preferred Alternative, several such curves are proposed at the maintenance facility. The closest noise-sensitive receptors are residences located along West Franklin Street and Franklintown Road less than 100 feet from the proposed facility property line, which is well within the FTA screening distance of 1,000 feet. As a result, exceedances of the FTA *moderate* noise impact criteria are predicted because of the combined effects from general maintenance activities and the switches. However, noise generated by the maintenance yard is not expected to result in adverse impacts at any of the closest receptors in the vicinity of the maintenance facility because any significant activities (such as wheel truing) would occur indoors. For example, maximum noise levels at Site M14 (residences along West Franklin Street opposite the Operations and Maintenance Facility) are predicted to range from

59 dBA from general yard activities to 63 dBA from wheel squeal along tight-radius curves. However, these maximum noise levels are well below the measured ambient level of 77 dBA L_{dn} at Site M14.

5.1.6 Noise Impacts from Ventilation Facilities

Maximum noise levels from ventilation fans and other mechanical equipment are not predicted to contribute to any noise impacts in the community under the Preferred Alternative. The fan plants would be operated only during emergencies or during required monthly maintenance testing and not for tunnel ventilation. For example, maximum noise levels from the fan plants are predicted to range from well below background to 52 dBA at Site M20 (residences along West Lombard Street at Calvert Street). Since the dominant noise source within fan plants, namely tunnel ventilation fans, would be located well inside the building and fitted with sound attenuators, no exceedances of the FTA impact criteria are predicted from fan plants.

5.1.7 Noise Impacts from Stations and Feeder Bus Operations

Feeder buses currently operate within the study area and would continue to operate under the Preferred Alternative. Therefore, the existing noise from feeder buses is included in the baseline measurements. Nevertheless, several routes would be modified or added as a result of the Red Line so that the majority of the feeder bus service operating along the Preferred Alternative would terminate at a rail transit station. For example, Route 15 (Security Square Mall to Perry Hall) would be replaced with three routes (15B, 15E and 15W). Other routes (such as Route 77 between Old Court Metro Station and Patapsco LRT Station) would operate at higher frequencies to encourage transit use and to provide capacity to support the heavier passenger loads anticipated when the Red Line is implemented. Finally, some bus stops would also be relocated to better accommodate the proposed Red Line LRT service in closer proximity to the stations.

However, these modifications to the feeder bus operations are not expected to result in significant or adverse noise effects in the community because of the existing bus activity. For example, maximum idling noise at residences along West Franklin and Mulberry Streets is expected to remain fairly constant at approximately 83 dBA, above the baseline noise levels of 77 and 73 dBA, respectively, measured at these locations. Therefore, the change in feeder bus operations is not predicted to exceed the FTA *moderate* or *severe* impact criteria along the Preferred Alternative.

5.1.8 Noise Impacts from LRT Warning Bells and Grade Crossing Bells

Because of the federal regulation to provide safety warnings at all 53 at-grade crossings proposed along the project corridor, noise levels from onboard warning bells and stationary crossing bells are predicted to contribute to exceedances of the FTA *moderate* impact criteria under the Preferred Alternative. For example, maximum noise levels from LRT warning bells are predicted to range from 54 dBA at Site M1 (Chadwick Elementary School) to 74 dBA at Site M26 (residences along West Mulberry Street). Similarly, maximum noise levels from stationary grade crossing bells (such as the low-profile Invensys devices) are predicted to range from 36 dBA at Site M1 (Chadwick Elementary School) to 69 dBA at Site M15 (residences along West Mulberry

Street). Overall, predicted noise levels from stationary grade crossing bells are predicted to contribute to almost 30 percent of the FTA *moderate* impacts under the Preferred Alternative.

5.1.9 Traffic Noise Impacts because of the Re-Alignment of I-70

In accordance with the SHA *Highway Noise Policy*, a peak-hour traffic noise assessment was conducted at residences adjacent to the re-aligned sections of I-70. Using the FHWA *Traffic Noise Model* (TNM) and level-of-service (LOS) 'C' traffic volumes under free-flow conditions, hourly equivalent noise levels were predicted for the Preferred Alternative. Based on the traffic noise modeling analysis for the re-aligned I-70 roadway, cumulative hourly noise levels from both traffic and LRT trains ranged from 48 dBA at Site M6 (a residence along Calvert Road) to 57 dBA at Site M7 (residences along James Ridge Road) to 63 dBA at Site M8 (residences along Stamford Road). However, none of the hourly noise levels are predicted to exceed the SHA noise abatement criterion of 66 dBA at any of the selected residences.

5.1.10 Operational Noise Impacts at Historic Properties

Although several historic and cultural resources were identified along the Preferred Alternative, many of these properties are not sensitive to transit noise. Industrial buildings and transportation structures such as bridges, tunnels and railroad corridors, for example, are not considered sensitive to transit noise. However, since many of the historic properties are actually historic districts, noise levels at residences within these historic districts were evaluated. Because of the large size of these districts, noise levels from the project are predicted to range from below the measured background levels to 74 dBA at Site M14 (residences located within the Greater Rosemont Historic District at West Franklin Street). Therefore, since almost all of the receptors identified within the FTA screening distances along the Preferred Alternative are part of a historic district, exceedances of the FTA impact *moderate* and *severe* criteria are predicted at historic properties as summarized in **Table 9**.

5.1.11 Operational Noise Impacts at Schools and Other Institutional Receptors

As listed in **Table 8**, several parks and schools were identified along the Preferred Alternative. At these institutional sites, the peak-hour L_{eq} descriptor was used to reflect their sensitivity to daytime noise. As summarized in **Table 8**, project L_{eq} noise exposure levels at parks along the Preferred Alternative are predicted to range from below background at Site M10 (St. William of York School and Church) to 58 dBA at Site M13 (a church along Edmondson Avenue). None of the project noise exposure levels at parks, schools or medical buildings are predicted to exceed the FTA *moderate* or *severe* impact criteria along the Preferred Alternative.

5.1.12 Operational Vibration Impacts

Unlike noise, which is assessed using cumulative noise levels over a one- or 24-hour period, transit vibration impacts are assessed based on individual events, such as a train passby. To reduce transit vibration impacts at residences and other sensitive receptors along the Preferred Alternative, the entire rail corridor would be constructed with continuously welded rail (CWR) track with ballast along at-grade sections and direct fixation along aerial or tunnel sections. These measures are expected to reduce vibration levels that are caused by steel wheels rolling over steel rails at rail joints. Along aerial sections, the sheer mass of the elevated structures and the additional separation between the train source and the ground-level receptors result in greater attenuation compared to at-grade track. At-grade crossings, embedded track at cross streets is not expected to result in any vibration impacts, because of the short section limited to the width of the cross street. All predicted vibration levels were compared with the FTA *frequent* impact criteria to assess the onset and severity of impact.

In addition to residences, schools and churches, two other highly vibration-sensitive receptors were identified along the preferred Alternative: the University of Maryland Proton Building proposed at Fremont and Baltimore Street; and the National Institute of Health (NIH) facility at the Johns Hopkins Bayview Medical Center campus. Both of these facilities include sensitive imaging equipment such as electron microscopes and magnetic resonance imaging (MRI) machines.

5.1.13 Vibration Impacts from LRT Vehicle Passbys

To show the variation in vibration levels along the alignment, transit vibration levels were predicted at the same receptor locations as for the noise analysis. As summarized in **Table 10**, maximum vibration levels from LRT vehicle pass-bys are predicted to range from below detection at Site M6 (residences along Calvert Road) to 67 VdB at Site M15 (residences along West Mulberry Street) to 71 VdB at Site M28 (medical building at Bayview Medical Center).

Table 10: Summary of Project Vibration Levels at Representative Receptors (in VdB)

Receptor		Land Use		Build		FTA Criteria	
ID	Description	Type[1]	FTA	Vibration	GB-NZ	"frequent"	GB-NZ
M01	Chadwick Elementary, Winder Rd	SCH	3	52	17	75	40
M02	Winder Rd at Calais Ct	RES	2	60	25	72	35
M03	Security Blvd	RES	2	61	26	72	35
M04	Days Inn, Whitehead Ct	MOT	2	**74**	39	72	35
M05	Baltimore St at I-70	RES	2	56	21	72	35
M06	Calvert Rd	RES	2	< ambient	< ambient	72	35
M07	Ingleside Ave at I-70	RES	2	59	24	72	35
M08	Kirkwood Rd at Forest Park Ave	RES	2	47	12	72	35
M09	Cooks Ln	RES	2	55	20	72	35
M10	St. William of York Church, Cooks Ln	CHU	3	52	17	75	40
M11	Edmondson Ave at Cooks Ln	RES	2	53	18	72	35
M12	Edmondson Ave at Glen Allen Dr	RES	2	51	16	75	40
M13	Edmondson Ave at Cathedral Cemetery	RES	2	64	29	75	40
M14	W. Franklin St at Franklintown Rd	RES	2	66	31	72	35
M15	W. Mulberry St at Smallwood St	RES	2	67	32	72	35
M16	W. Mulberry St. at N. Gilmore St	RES	2	62	27	72	35
M17	W. Mulberry St at Fremont Ave	RES	2	52	17	72	35
M18	N. Fremont Ave at Baltimore St	RES	2	59	24	75	40
M19	University of Maryland Medical	SCH	3	54	19	75	40

Table 10: Summary of Project Vibration Levels at Representative Receptors (in VdB)

Receptor		Land Use		Build		FTA Criteria	
ID	**Description**	**Type[1]**	**FTA**	**Vibration**	**GB-NZ**	**"frequent"**	**GB-NZ**
	School						
M20	W. Lombard St at Calvert St	RES	2	60	25	72	35
M21	President St. at Eastern Avenue	RES	2	52	17	75	40
M22	Fleet St at Central Ave	RES	2	57	22	75	40
M23	Fleet St at Broadway	RES	2	53	18	72	35
M24	Boston St at Montford Ave	RES	2	51	16	72	35
M25	Boston St at Potomac St	RES	2	64	29	72	35
M26	Boston St at Conklin St	RES	2	68	33	72	35
M27	Alpha Commons Dr	RES	2	63	28	72	35
M28	E. Lombard St	MED	3	71	36	75	40

Notes: 1 Maximum vibration velocity levels (in VdB) are reported for all receptor sites.
2 Exceedances of the FTA *frequent* criteria are **bold** and underlined.
Source: MTA, September 2012.

As summarized in **Table 11**, corridor-wide vibration levels are predicted to exceed the FTA *frequent* criterion of 72 VdB at 45 residences. Many of these impacts are because of the proximity of residences to proposed switches. Vibration levels are also predicted to exceed the site-specific criterion of 300 □ips at the proposed University of Maryland Proton Building. Ground-borne noise levels are also predicted to exceed the FTA *frequent* criterion of 35 dBA at 49 residences. The predicted corridor-wide vibration impacts are shown graphically in **Appendix B**.

Table 11: Corridor-wide Project Vibration Impacts under the Preferred Alternative

ID[1]	Location	Type Use[2]	Impact (Frequent)	No. Residences Affected		Major Source(s) Contributing to Impact[3]
				GB-VIB	**GB-NZ**	
	FTA Category 1					
4	Downtown Tunnel	MED	*Frequent*	1	0	Passbys
	FTA Category 2					
1	West	RES	*Frequent*	1	2	Switches
2	Cooks Lane	RES	*Frequent*	0	0	None
3	US 40	RES	*Frequent*	44	47	Passbys & Switches
4	Downtown Tunnel	RES	*Frequent*	0	0	None
5	East	RES	*Frequent*	0	0	None
	Total FTA Category 2		Frequent	45	49	
	FTA Category 3			0	0	
4	Downtown Tunnel	MED	*Frequent*	0	0	None
	Total – All Uses		**Total**	**46**	**49**	

Notes: 1 ID corresponds to general location as shown in Appendix B.

2 SF = Single-Family Residence; MF = Multi-Family Residence.
3 Major sources include LRT passbys, LRT warning bells, and switches or special track work. The operations and maintenance facility and TPSS are not expected to be a major source for impacts in any noise-sensitive locations.
Source: MTA, May 2012.

5.1.14 Vibration Impacts from Special Track Work

Because of rail discontinuities at switches, vibration levels from LRT vehicle pass-bys over switches are predicted to range from below background to 60 VdB at Site M2 (residences along Winder Road) to 63 VdB at Site M14 (residences along West Franklin Street) to 71 VdB at Site M28 (medical building at the Bayview Medical Center). The vibration levels at Site M14, for example, range from 63 VdB for switches to 66 VdB for LRT passbys along tangent track.

5.1.15 Impacts from the Operations and Maintenance Facility

Although several multi-family residences are identified within the FTA screening distance of 150 feet of the proposed Operations and Maintenance Facility, impacts because of vibration are unlikely. Vibration generated from slow-moving LRT vehicles over switches and other activities at the maintenance yard would not exceed the FTA vibration impact criteria at any of the closest receptors in the vicinity of the Operations and Maintenance Facility.

However, vibration because of in-service trains operations over switches used to access the maintenance facility would contribute to exceedances of the FTA Category 2 *frequent* criterion of 72 VdB at 27 residences along West Franklin Street. Similarly, ground-borne noise because of these switches would also contribute to exceedances of the FTA Category 2 *frequent* criterion of 35 dBA at 29 residences. No FTA Category 3 land-uses were identified in the vicinity of the Operations and Maintenance Facility.

5.1.16 Operational Vibration Impacts at Historic Properties

Although several historic and cultural resources were identified along the Preferred Alternative, many of these properties are not sensitive to transit vibration. Industrial buildings and transportation structures such as bridges, tunnels and railroad corridors, for example, are not considered sensitive to transit noise. However, since many of the historic properties are actually historic districts, vibration levels at residences within these historic districts were evaluated. Because of the large size of these districts, vibration levels from the project are predicted to range from below background to 67 VdB at Site M15 (residences along West Mulberry Street). Therefore, since almost all of the receptors identified within the FTA screening distances along the Preferred Alternative are part of a historic district, exceedances of the FTA *frequent* impact criteria are predicted at historic properties as summarized in **Table 11**.

5.1.17 Operational Vibration Impacts at Schools and Other Institutional Receptors

As listed in **Table 10**, maximum vibration levels at schools and other institutional receptors along the Preferred Alternative are predicted to range from below background to 52 VdB at Site M1 (Chadwick Elementary School) to 64 VdB at Site M13 (Cathedral Cemetery) to 71 VdB at Site M28 (a medical building at the Bayview Medical Center). At highly sensitive buildings such as the University of Maryland's Proton Building at the BioPark, ground-borne vibration levels from future Red Line operations of 46 VdB are predicted to exceed the building-specific criterion of 40 VdB (or 100 µips). However, at the National Institute of Health (NIH) building at the Johns Hopkins Bayview Medical Center, ground-borne vibration levels from future Red Line operations of 46 VdB are not predicted to exceed the building-specific criterion of 50 VdB (or 300 µips). Based on the modeling analysis, none of the project vibration levels at the selected receptor sites summarized in **Table 10** (including parks, schools, churches, or hospitals) are predicted to exceed the FTA *frequent* impact criteria along the Preferred Alternative except at the proposed Proton Building.

5.1.18 Cumulative Impacts

Noise levels along the project study corridor would be somewhat increased by the presence of the Preferred Alternative, since it would involve operating transit vehicles. Some of the other planned projects in the area could also increase noise levels because of resultant changes in traffic volumes, fleet mix (e.g., heavy trucks) and speed. With the mitigation measures proposed in Section 5.1.19, all project-related noise and vibration impacts would be reduced to less than adverse, since there would be no violations of FTA's *severe* impact criteria or the ground-borne vibration thresholds. In other words, with mitigation, no FTA *severe* noise impacts or vibration impacts are predicted along the project study corridor. Predicted exceedances of the FTA *moderate* impact criteria would also be minimized as a result of the proposed mitigation. Since the Red Line project would provide an alternative mode of transportation to many destinations in the area, it is anticipated that it would reduce the number of auto trips and the noise levels associated with these foregone auto trips. Therefore, the Preferred Alternative would not contribute to adverse cumulative impacts and may provide a beneficial overall effect.

5.1.19 Operational Mitigation Measures

Since noise impacts are predicted for the Preferred Alternative, mitigation measures were investigated to determine their effectiveness in reducing *moderate* and *severe* noise impacts from LRT operations. The following mitigation measures were evaluated for their potential to eliminate both *moderate* and *severe* noise impacts along the project corridor:

- Median barriers or other supplemental safety measures at-grade crossings to eliminate the need to sound warning horns, particularly at night; and,
- Relocating switches away from sensitive receptors;
- Utilizing approved control measures (such as spring frogs) to eliminate the gap in traditional switches; or,
- Track-side low-profile noise barriers or parapets to shield residents from wayside train passbys.

5.1.20 No-Build Alternative

Since no operational noise or vibration impacts are expected under the No-Build Alternative, no mitigation is proposed.

5.1.21 Operational Noise Mitigation Measures

Using conservative or worst-case modeling assumptions, *moderate* (and one *severe*) noise impacts were predicted at residences adjacent to the following grade crossings:

- Security Boulevard at Greengage Road – Segment 1 – 1 *moderate* impact
- Edmondson Avenue at:
  - Wildwood Parkway – Segment 3 – 1 *moderate* impact
  - North Loudon Avenue – Segment 3 – 1 *moderate* impact
  - Mount Holly Street – Segment 3 – 2 *moderate* impacts
  - Allendale Street – Segment 3 – 33 *moderate* impacts
  - Edgewood Street – Segment 3 – 3 *moderate* impacts
  - Denison Street – Segment 3 – 4 *moderate* impacts
  - North Hilton Street – Segment 3 – 1 *moderate* impact
  - West Franklin Street – Segment 3 – 5 *moderate* impacts
- West Franklin Street at:
  - North Franklintown Road – Segment 3 – 4 *moderate* impacts
  - Ashburton Street – Segment 3 – 8 *moderate* impacts
  - East track connector to Calverton Road – Segment 3 – 6 *moderate* impacts
  - Evergreen Street – Segment 3 – 2 *moderate* impacts
  - North Warwick Avenue – Segment 3 – 2 *moderate* impacts
  - North Payson Street – Segment 3 – 1 *moderate* impact
- Mulberry Street at:
  - North Smallwood Street – Segment 3 – 1 *moderate* impact
  - North Payson Street – Segment 3 – 4 *moderate* impacts
- Boston Street at:
  - Safeway Driveway – Segment 5 – 3 *moderate* impacts
  - South Lakewood Avenue – 1 *severe impact*
  - South Conklin Street – Segment 5 – 1 *moderate* impact

Implementing approved control measures at these grade crossings, such as median barriers, four quadrant gates or other supplemental safety measures promulgated by MTA and the Federal Railroad Administration (FRA), would eliminate the need for LRT warning bells and stationary crossing bells particularly during the nighttime period. However, during Final Design, the feasibility of eliminating or minimizing use of the LRT warning and crossing bells should be investigated to comply with the current and future MTA policy on all new LRT corridors (such as the Purple Line).

Noise impacts were also predicted at residences along West Franklin Street because of the rail discontinuities associated with the switches used to access the proposed Maintenance Facility. To mitigate these predicted impacts, approved control measures are recommended including, for example, spring frogs (to eliminate the gap in the switch) or low-profile noise barriers to shield nearby residences from the clickety-clack of revenue service trains over these switches.

5.1.22 Operational Vibration Mitigation Measures

Using conservative or worst-case modeling assumptions, ground-borne vibration and noise impacts were predicted at residences opposite the proposed Maintenance Facility along West Franklin Street. Similar to noise, the predicted vibration impacts are because of the rail discontinuities associated with the switches used to access the proposed Maintenance Facility. To mitigate these predicted impacts, approved control measures (such as spring frogs) are recommended to eliminate the gap in the switch and the vibration impact caused when the steel wheel strikes this gap.

5.1.23 Impacts Remaining After Mitigation

Noise and vibration control measures were evaluated to eliminate or reduce the severity of the predicted impacts along the Project Study Corridor. As a result, no residual impacts after mitigation would remain. Similarly, all vibration impacts would be fully mitigated to a level of no adverse effect or less than significant impact.

6. Short-Term Construction Effects and Mitigation

6.1 Construction Noise

Noise levels from construction activities along the Preferred Alternative, although temporary, could be a nuisance at nearby sensitive receptors such as residences and schools. Noise levels during construction are difficult to predict and vary depending on the types of construction activity and the types of equipment used for each stage of work. Heavy machinery, the major source of noise in construction, is constantly moving in unpredictable patterns and is not usually at one location very long. Project construction activities include, for example, constructing track bed, installation of bents for the aerial structures, tunnel excavation, relocating utilities, renovating grade crossings, and constructing stations.

In order to gauge the level of potential impact from temporary construction activities, preliminary construction scenarios were developed. In general, however, it is recognized that there would be adverse impacts during construction in some locations. In addition, activities associated with construction staging and/or material lay down areas can result in adverse noise impacts if they take place in noise-sensitive areas. Similarly, there is also the potential for noise increases along detour routes and truck haul routes. This analysis makes conservative assumptions regarding construction noise in order to ensure that potential maximum adverse impacts are analyzed and disclosed consistent with NEPA requirements. However in later stages of project design when a detailed construction plan is available this analysis including mitigation should be refined.

The bulk of the construction normally occurs during daylight hours when some residents are not at home, when residents who are at home are less sensitive to construction activities, and when other community noise sources contribute to higher ambient noise levels. However, some construction activities would also occur during the nighttime and on weekends to complete the project sooner and reduce the overall duration of impact on the community. Since most construction activities are generally expected to last about 12 to 18 months at any one location, depending on the type of activity, the overall project construction period is expected to last approximately seven years. As a result, significant noise impacts are expected, particularly on those receptors adjacent to the alignment without adequate noise control measures. Therefore, MTA is committed to minimizing impacts in the community by requiring its contractors to implement appropriate noise control measures that are expected to eliminate impacts and minimize extended disruption of normal activities.

Construction noise differs from transit noise in two ways:

- Construction noise lasts for the duration of the construction contract and is usually limited to daylight hours when most human activity occurs. Construction activities are generally of a short duration and, depending on the nature of construction operations, could last from seconds (such as for a truck passing by) to months (such as when constructing a bridge at an overpass). Some construction activities, such as tunneling and underground station excavation, could last for several years. Transit noise occurs during most or all of the day and night and is a permanent part of the acoustical environment, such as highway noise.

- Construction noise is also intermittent and depends on the type of operation, location, and function of the equipment as well as the equipment usage cycle. Transit noise, on the other hand, is present in a more continuous fashion at scheduled times and occurs after construction activities are completed.

To ensure that noise impacts are minimized during construction, all construction activities are intended to comply with MTA's design criteria. Although MTA, as a state-chartered agency, is exempt from local noise ordinances, MTA is committed to consistency with local construction noise limits whenever feasible and reasonable in accordance with its own construction specifications. For example, MTA's contractor would utilize control measures from its own specifications that effectively minimize noise and vibration impacts in the community, such as:

- Conducting all construction activities during the daytime whenever possible;
- Requiring special permits for all construction within a specified distance and a specified time period for residential zones during the night and weekends;
- Using construction equipment with effective noise-suppression devices;
- Using noise control measures, such as enclosures and noise barriers, as necessary to protect the public and achieve compliance with MTA's design criteria; and,
- Conducting all operations in a manner that would minimize, to the greatest extent feasible, disturbance to the public in areas adjacent to the construction activities and to occupants of nearby buildings.

Along the Preferred Alternative, construction activities would include track-laying for both aerial and at-grade sections, tunnel excavation, passenger stations, bridges, park-and-ride facilities, and an operations and maintenance facility. Typical distances at which an exceedance of the MDE noise limits of 90 dBA at residence during the daytime, 55 dBA at residences during the nighttime and 62 dBA at non-residential receptors is predicted ranges from 177 feet to 3,155 feet to 1,409 feet, respectively. As a result of these preliminary construction noise estimates, construction activities are predicted to exceed both the MDE daytime and nighttime noise limits at almost every residence and commercial property within the project study area.

The total number of exceedances of the MDE L_{max} noise criteria is summarized in **Table 12** for both daytime and nighttime construction activities. Because of the large impact distances based on the MDE criteria, exceedances of the MDE daytime and nighttime noise L_{max} noise limits are predicted at all 1,538 receptors identified within the project screening distance. For this analysis, the construction activities were applied to both daytime and nighttime periods.

Table 12: Summary Results of the Construction Noise and Vibration Assessment

Construction		Noise, L_{max}		Vibration	
Activity	**Type**	**Daytime**	**Nighttime**	**PPV, ips**	**RMS, VdB**
Alignment	Surface	632	903	2	230
Alignment	Tunnel	504	965	38	577
Station Excavation	Tunnel	6	880	1	13
Portal Excavation	Tunnel	23	1,440	1	57
Maintenance Facility	Surface	0	889	0	0
	Totals	1,153	385	39	807

6.2 Construction Vibration

Unlike noise, vibration levels from construction activities are not cumulative but rather dependent on the type of activity and equipment used. Vibration is also dependent on the ground and terrain conditions, the presence of underground utilities, and the type and condition of the building at the receptor. As a result, except for digging and pounding activities in hard soils, most construction activities do not contribute to vibration impacts, because of the typically long distance between the activity and the sensitive receptor.

Along the Preferred Alternative, construction activities would include the use of bulldozers, dump trucks, vibratory rollers, blasting and tunnel boring machines (TBM). Blasting and the use of impact pile drivers would be avoided whenever possible to eliminate the potential for vibration impacts (such as minor cosmetic structural damage) at nearby sensitive receptors. The distances at which an exceedance of the FTA vibration damage criterion of 0.5 ips would occur (for typical timber and masonry residences) ranges from 8 feet for surface track laying to 30 feet for tunnel boring activities. However, for highly sensitive buildings, such as the proposed University of Maryland Proton Building at the BioPark, tunnel boring activities are predicted to exceed the 100 μips threshold limit within 1,875 feet of the alignment. In accordance with the FTA guidelines, the vibration limit is used during the environmental impact assessment phase to identify potential problem locations should be addressed in more detail during Final Design. The FTA criteria are intended to be used more as an indicator of potential damage rather than a definitive evaluation of impact. During Final Design when details of the actual construction equipment would be refined, a more definitive evaluation of potential impact and damage is recommended to address these potential concerns.

Similarly, the distances at which an exceedance of the FTA vibration *frequent* annoyance criterion of 72 VdB for residences and other FTA Category 2 land uses would occur, ranges from 79 feet for surface track laying to 291 feet for tunnel boring activities. As shown in **Table 12**, construction activities are predicted to exceed the FTA damage criteria at 36 residences and the proposed Proton Building from downtown tunneling construction activities. Similarly, over construction vibration levels are also predicted to exceed the FTA *frequent* annoyance criteria at 577 receptors from tunneling activities and an additional 230 receptors from surface track laying activities. The FTA *frequent* event category was used to assess impact from perceptible vibration events, since not all construction activity would be perceptible.

6.3 Construction Mitigation Measures

Noise and vibration impacts are expected during construction of the Red Line at residences and other sensitive receptors along the proposed build alternative alignments. As a result, MTA is committed to providing noise and vibration control measures during construction whenever feasible and reasonable in accordance with its own construction specifications to mitigate these impacts and to achieve consistency with the local and MDE noise ordinances as part of the Preferred Alternative. To reduce temporary construction noise and vibration impacts that are expected along the Preferred Alternative, several “good housekeeping” practices are recommended. For example, the following noise and vibration control measures could be incorporated into the construction process:

- Use construction methods that avoid pile-driving at locations containing noise- and vibration-sensitive receptors, such as residences, schools, and hospitals. Whenever possible, MTA’s contractor would consider using cast in place drilled hole (CIDH) or drilled piles rather than impact pile drivers to reduce excessive noise and vibration.
- Conduct a survey of the closest receptors (particularly fragile historic properties) to determine the baseline structural integrity and condition of walls and joints. These surveys could include the installation of strain gauges or a photographic documentation of the interior walls and exterior façade as a basis for comparison after construction is completed. Depending on the baseline conditions of the nearby buildings, an appropriate construction and monitoring plan would be developed to minimize potential damage to susceptible structures.
- Where practical, erect temporary noise barriers between noisy activities and noise-sensitive receptors.
- Locate construction equipment and material staging areas away from sensitive receptors. Route construction traffic and haul routes along roads in non-noise-sensitive areas where possible.
- Require contractors to use best available control technologies to limit excessive noise and vibration when working near residences (e.g., CIDH piles).
- Whenever possible, conduct all construction activities during the daytime and during weekdays in accordance with the MDE noise policy.
- Adequately notify the public of construction operations and schedules. Methods such as construction-alert publications or a Noise Complaint Hotline could be used to handle complaints quickly.
- Where possible, consideration should be given to early construction of permanent barriers to shield receptors from some construction generated noise.

All mitigation measures would be confirmed during the Final Design phase of the project when the details of the project components and the construction scenarios have been finalized.

7. References

ANSI. American National Standard S12.9-1992/Part 2. *Quantities and Procedures for Description and Measurement of Environmental Sound*. Part 2: Measurement of Long-term, Wide-Area Sound. Standards Secretariat, Acoustical Society of America, New York, NY.

ANSI. American National Standard S12.9-1993/Part 3. *Quantities and Procedures for Description and Measurement of Environmental Sound*. Part 3: Short-Term Measurements with an Observer Present. Standards Secretariat, Acoustical Society of America, New York, NY.

US Department of Transportation, Federal Transit Administration (FTA). 2006. FTA-VA-90-1003-06. *Transit Noise and Vibration Impact Assessment*. Office of Planning and Environment. Washington, DC.

US Department of Transportation, Federal Railroad Administration (FRA). August 17, 2006. *49 CFR 222 and 229. Use of Locomotive Horns at Highway-Rail Grade Crossings; Final Rule*. Washington, DC.

US Department of Transportation, Federal Highway Administration (FHWA). *Highway Traffic Noise: Analysis and Abatement Guidance*, FHWA-HEP-10-025, July 2010.

Maryland Department of Transportation, State Highway Administration, *Highway Noise Policy*, Baltimore, MD, April 13, 2011, effective: July 13, 2011.

RL GEC. 2012. "DRAFT Advanced Vehicle Design, Part 1: Rail Vehicle Design Criteria, Advanced Conceptual Design", August 2010.

RL GEC. 2012. "Volume 1 – Composite Civil and Track Plans, Red Line Light Rail transit System, Preliminary Engineering, Contract No. T-0862-0120", Baltimore, MD, In-Progress March 6, 2012.

APPENDIX A
EXPANDED NOISE AND VIBRATION IMPACT

Figure A: Predicted Noise and Vibration Impacts along the Preferred Alternative

Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

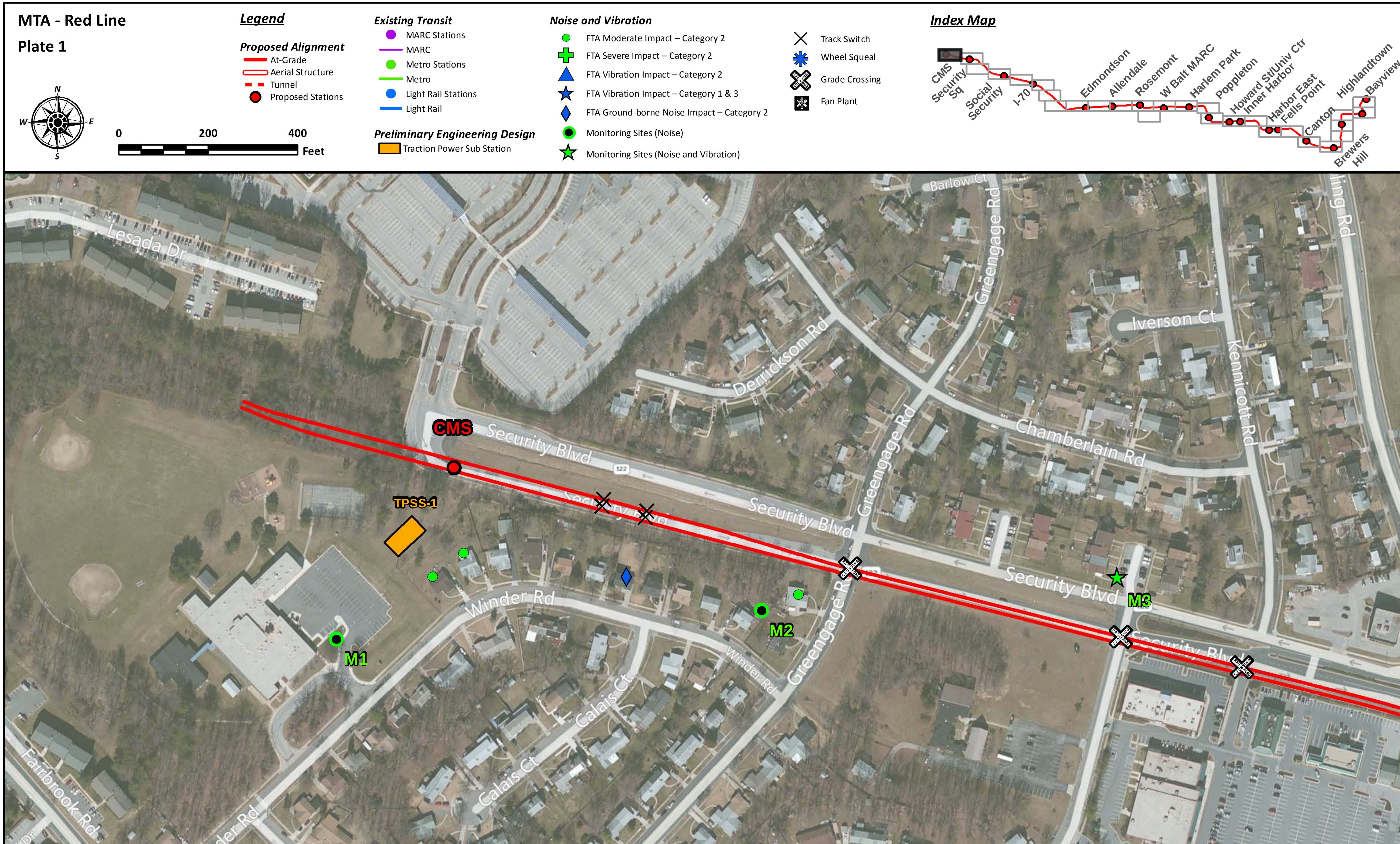


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

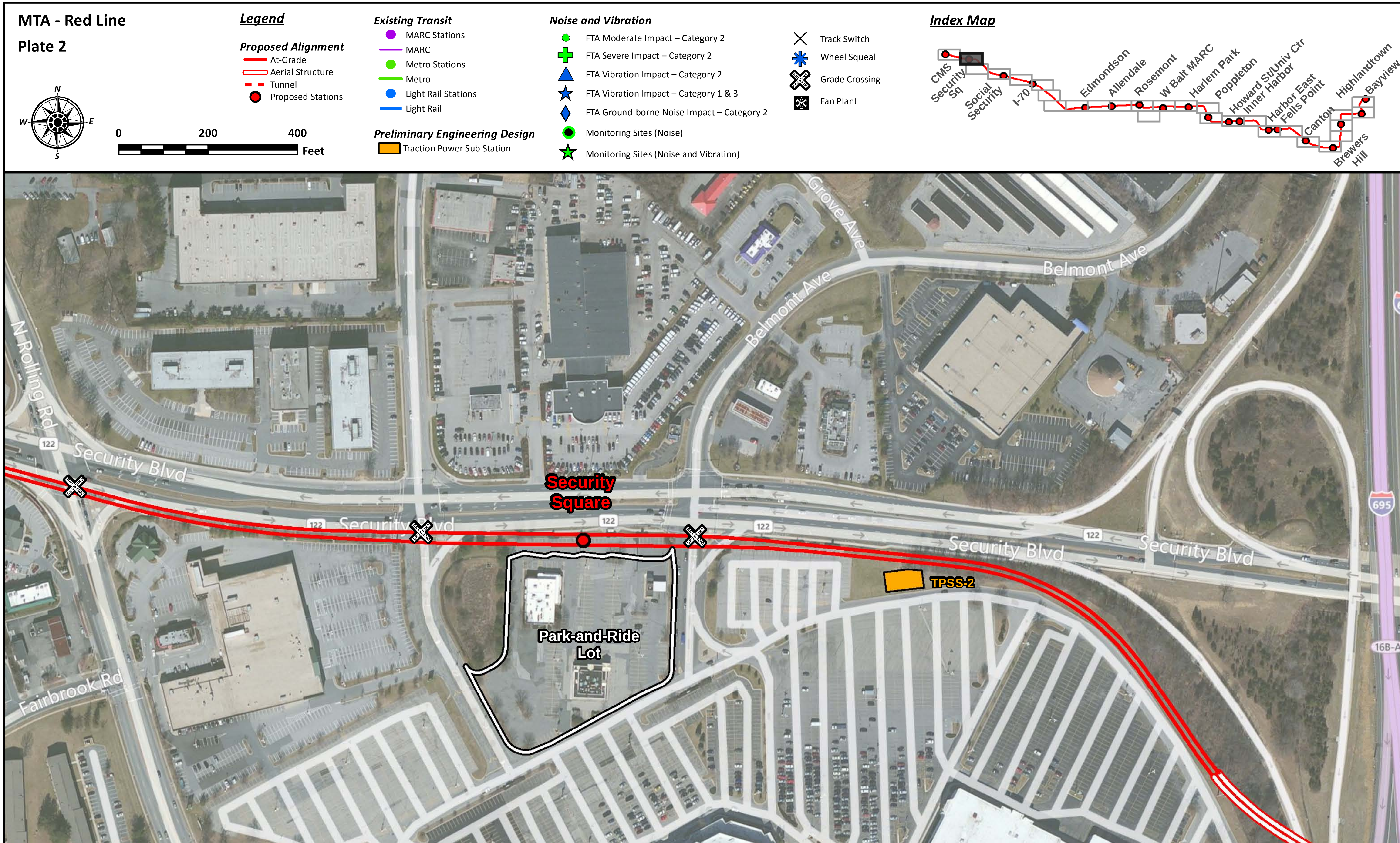


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

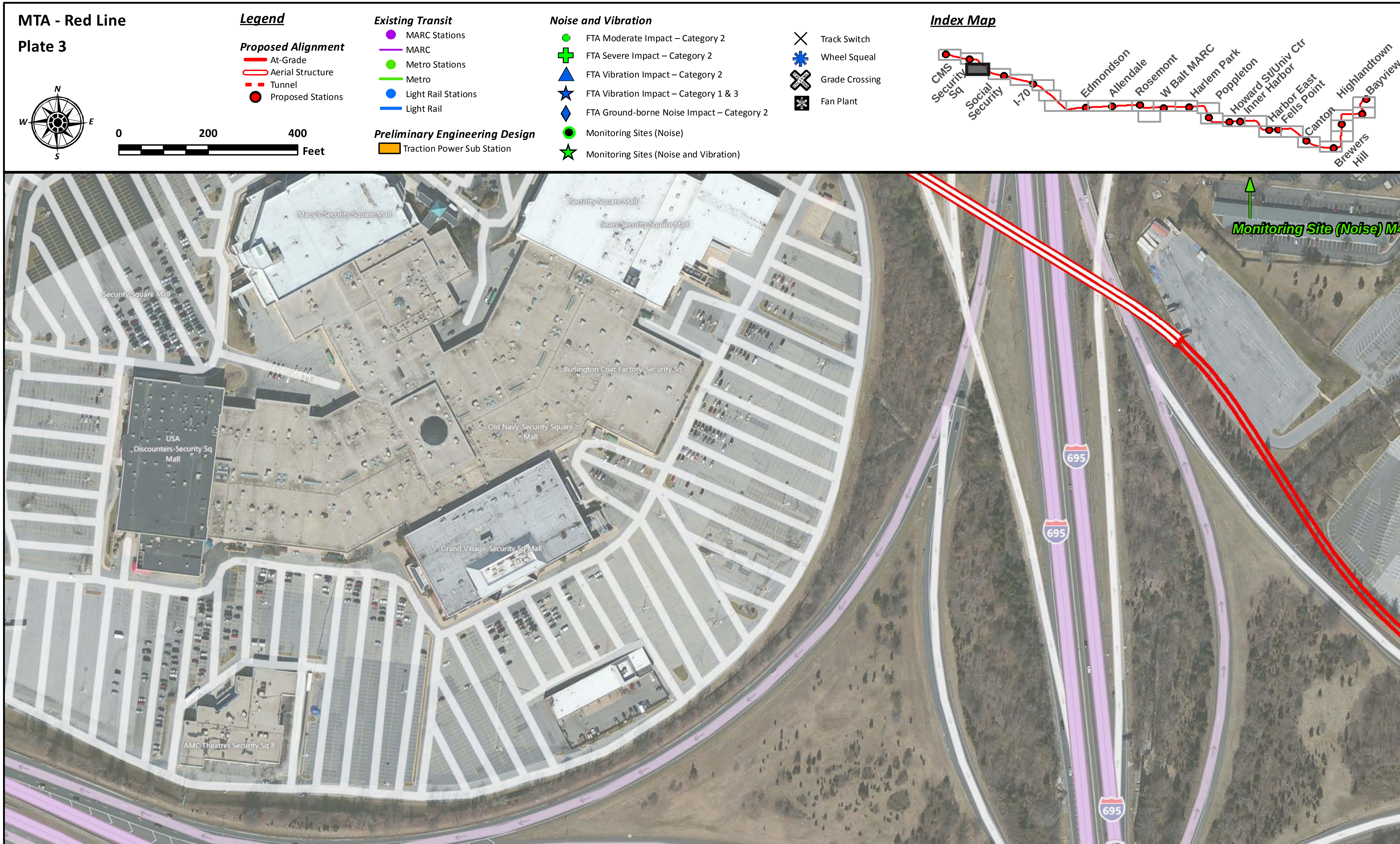


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

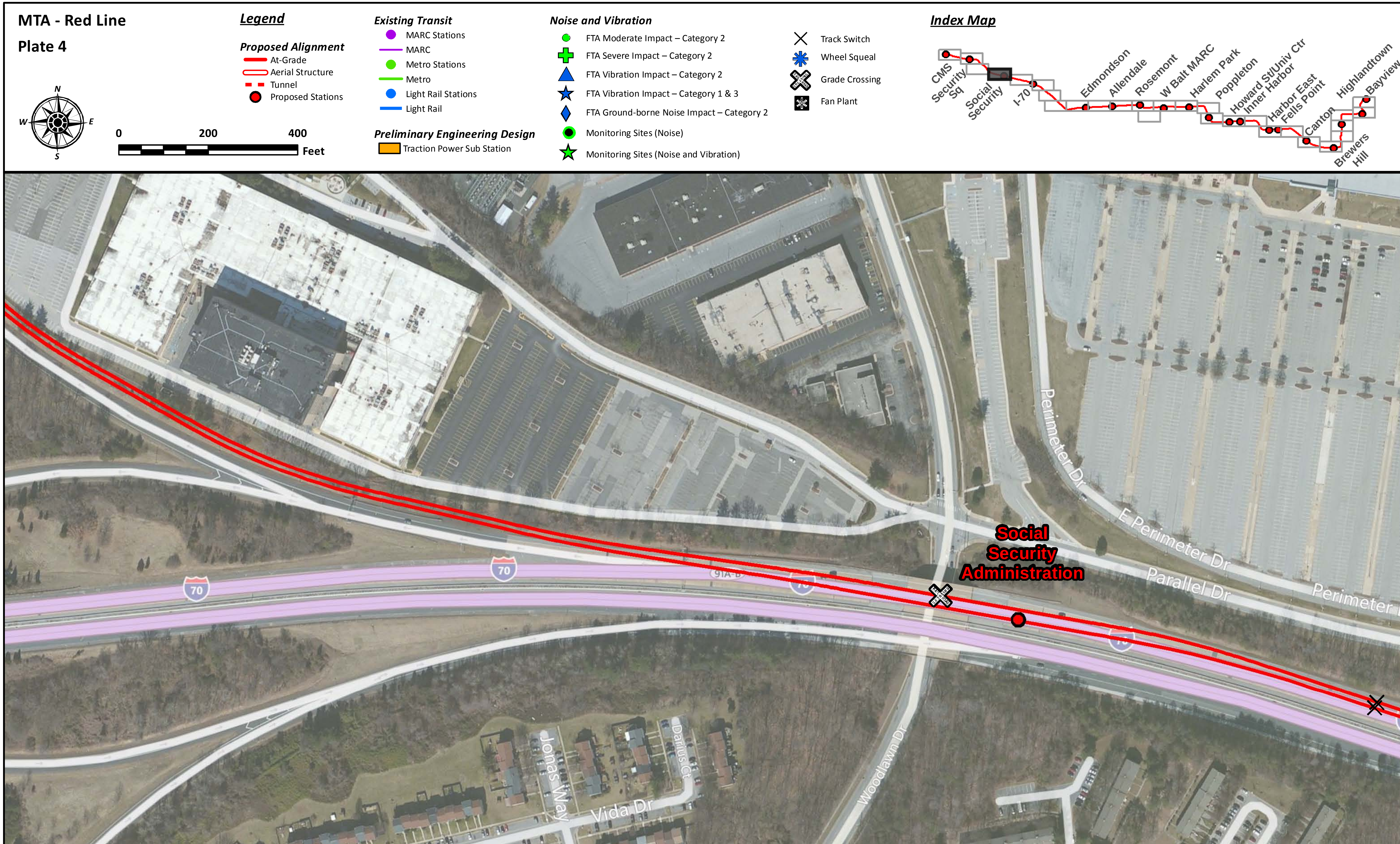


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

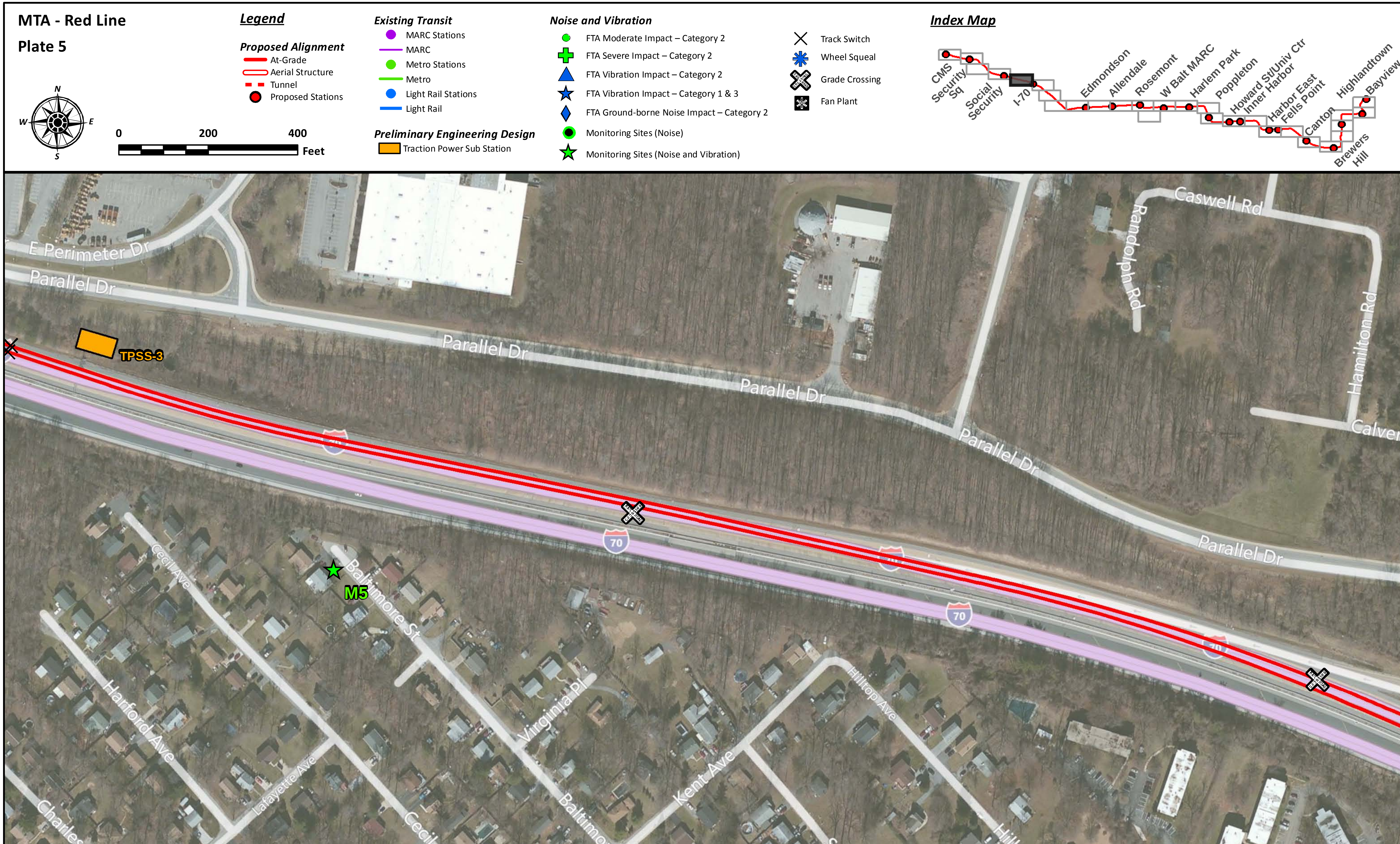


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

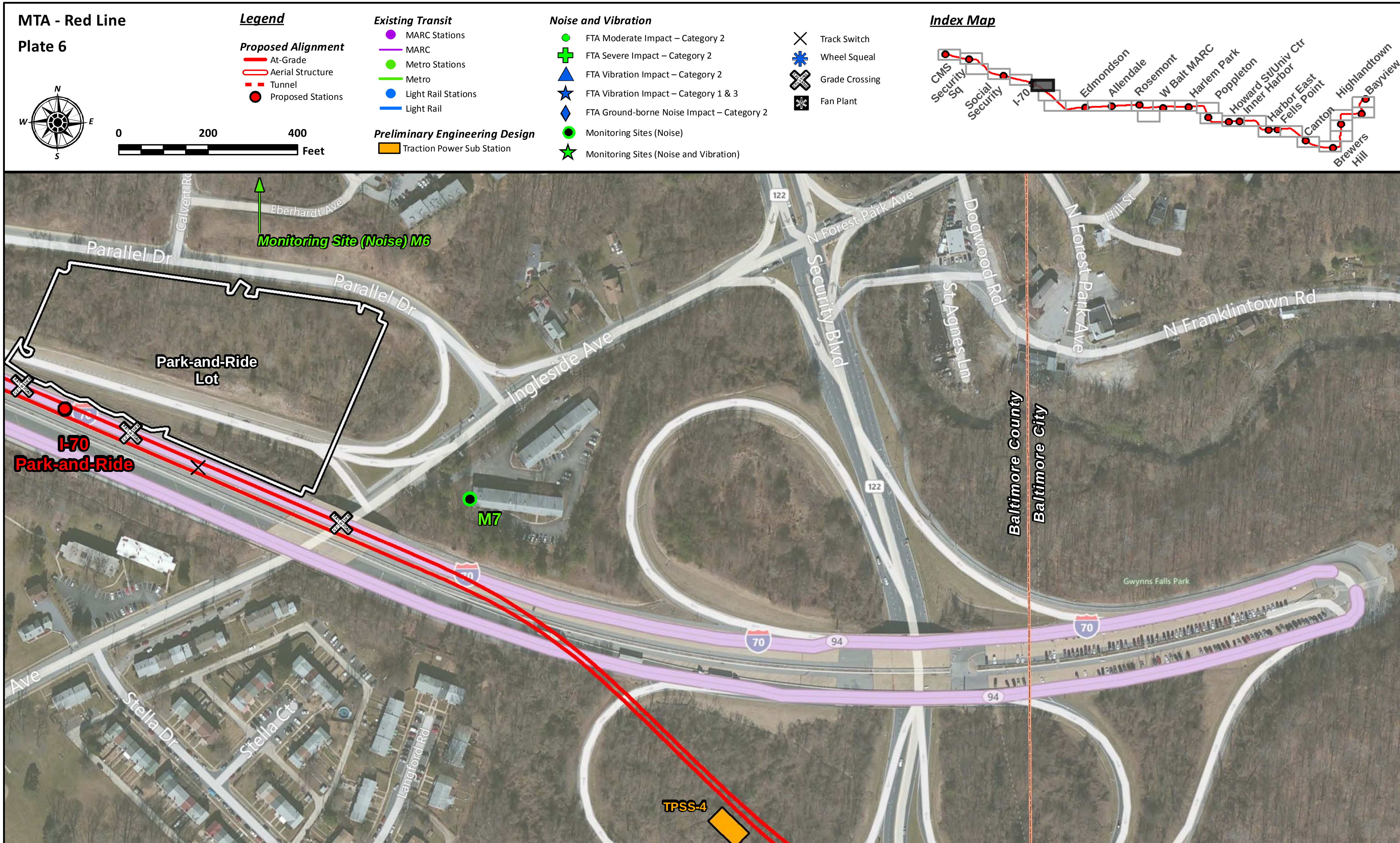


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

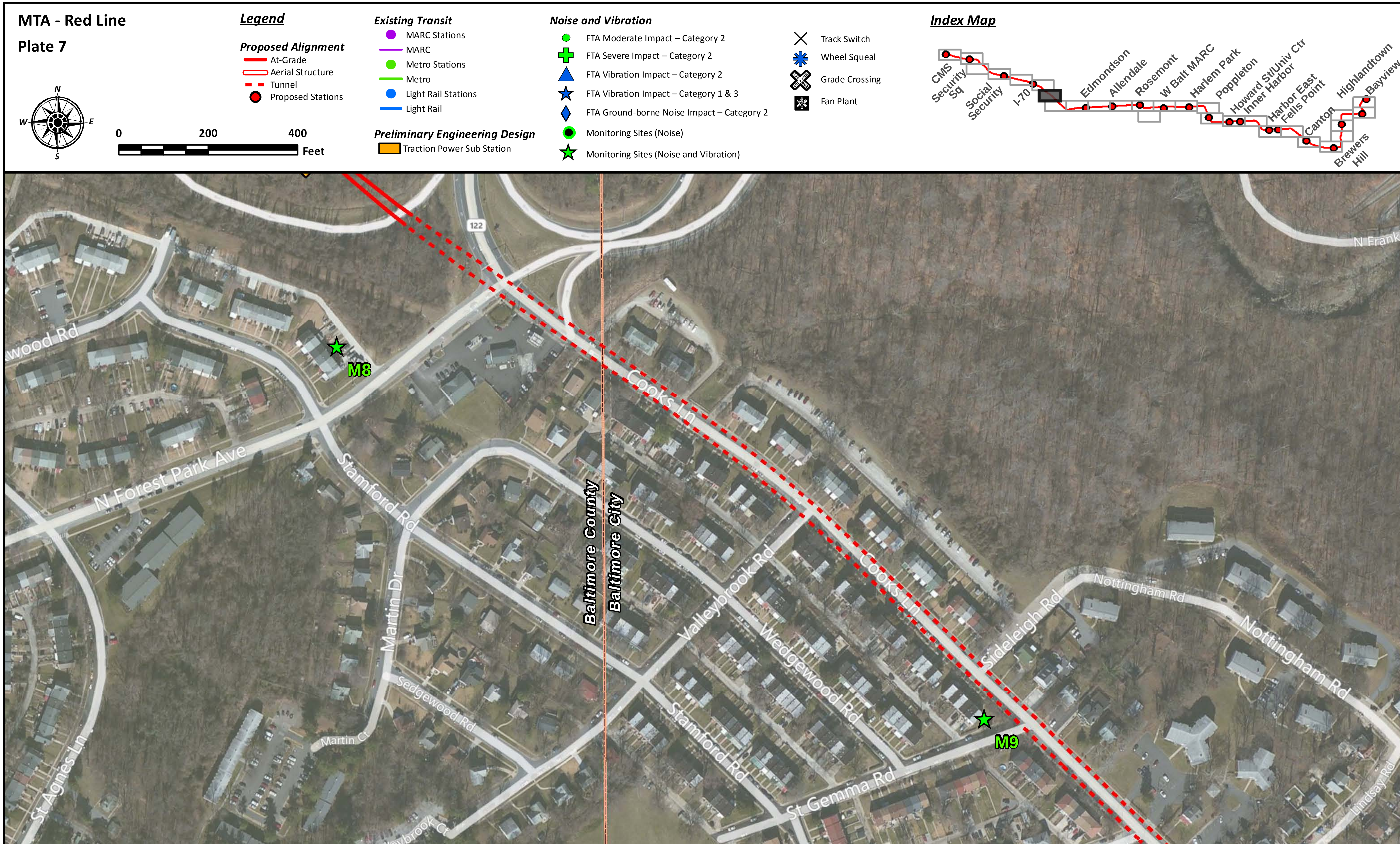


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

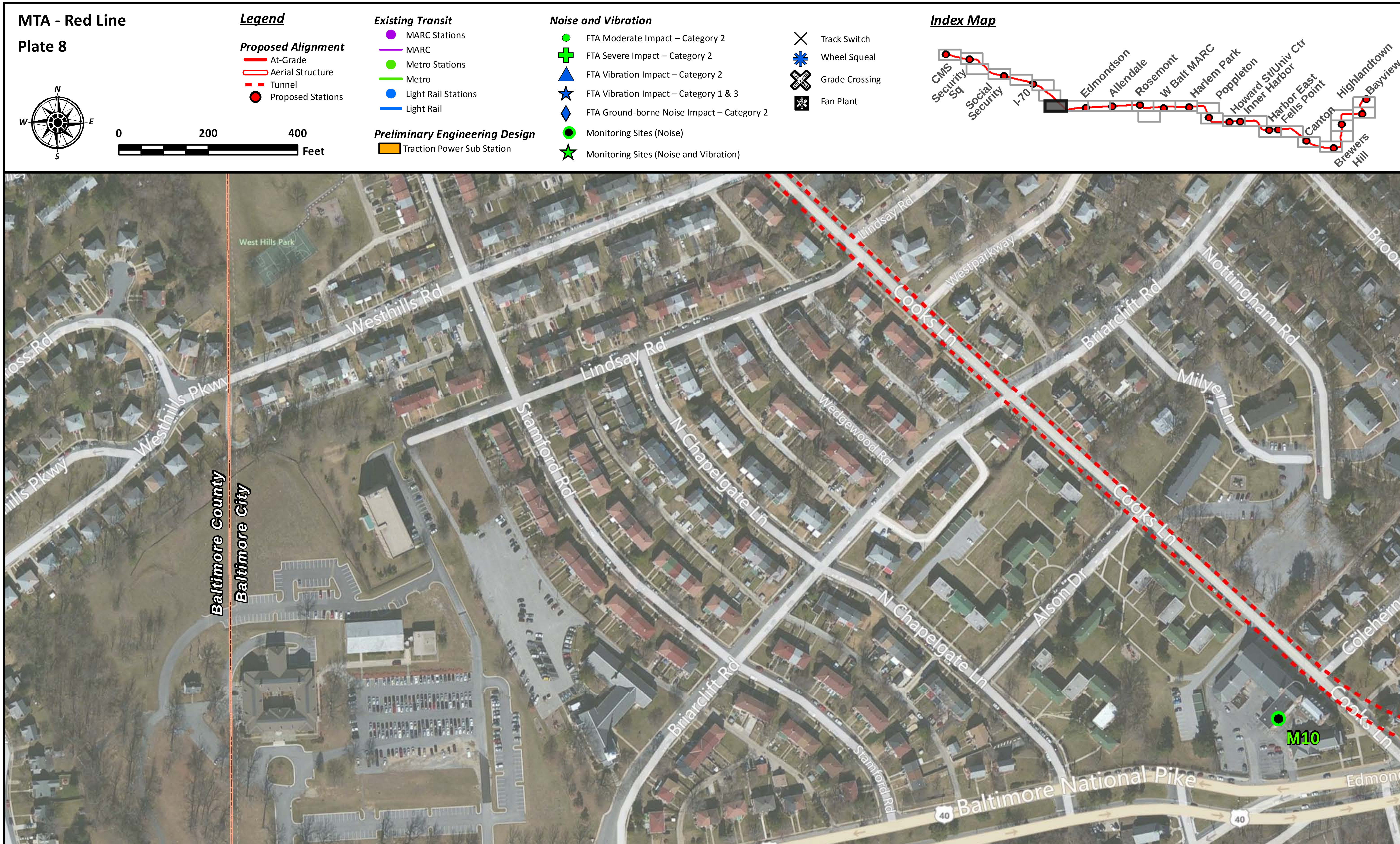


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

MTA - Red Line

Plate 10

N W E S

0 200 400 Feet

Legend

Proposed Alignment
- At-Grade
- Aerial Structure
- Tunnel
- Proposed Stations

Existing Transit
- MARC Stations
- MARC
- Metro Stations
- Metro
- Light Rail Stations
- Light Rail

Preliminary Engineering Design
- Traction Power Sub Station

Noise and Vibration
- FTA Moderate Impact – Category 2
- FTA Severe Impact – Category 2
- FTA Vibration Impact – Category 2
- FTA Vibration Impact – Category 1 & 3
- FTA Ground-borne Noise Impact – Category 2
- Monitoring Sites (Noise)
- Monitoring Sites (Noise and Vibration)
- Track Switch
- Wheel Squeal
- Grade Crossing
- Fan Plant

Index Map

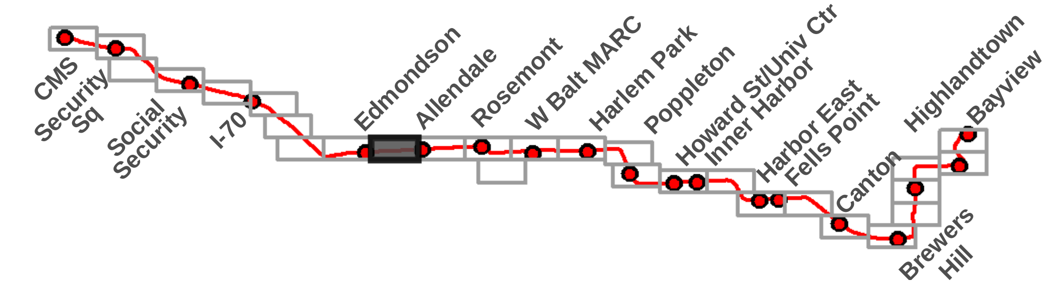


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

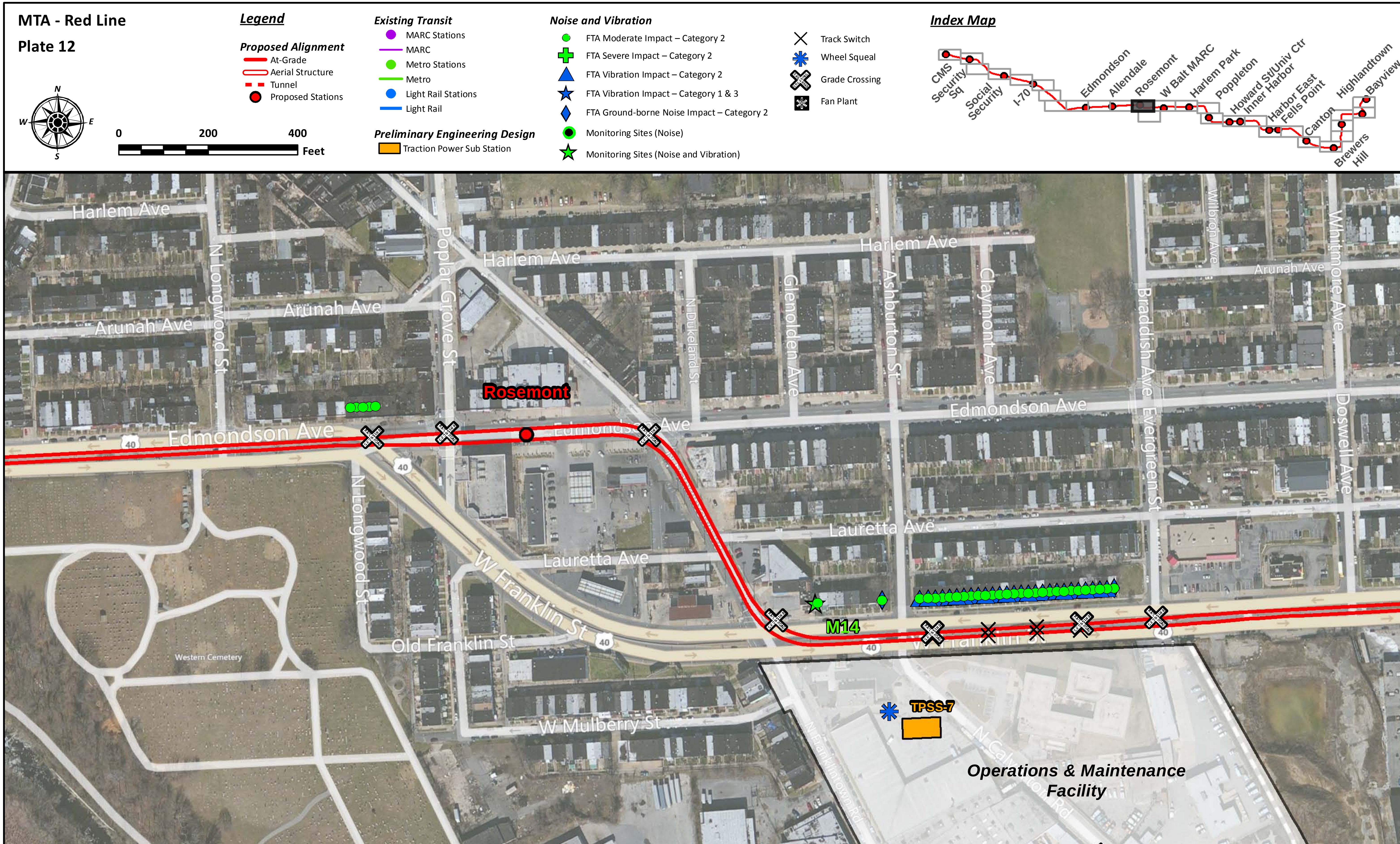


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

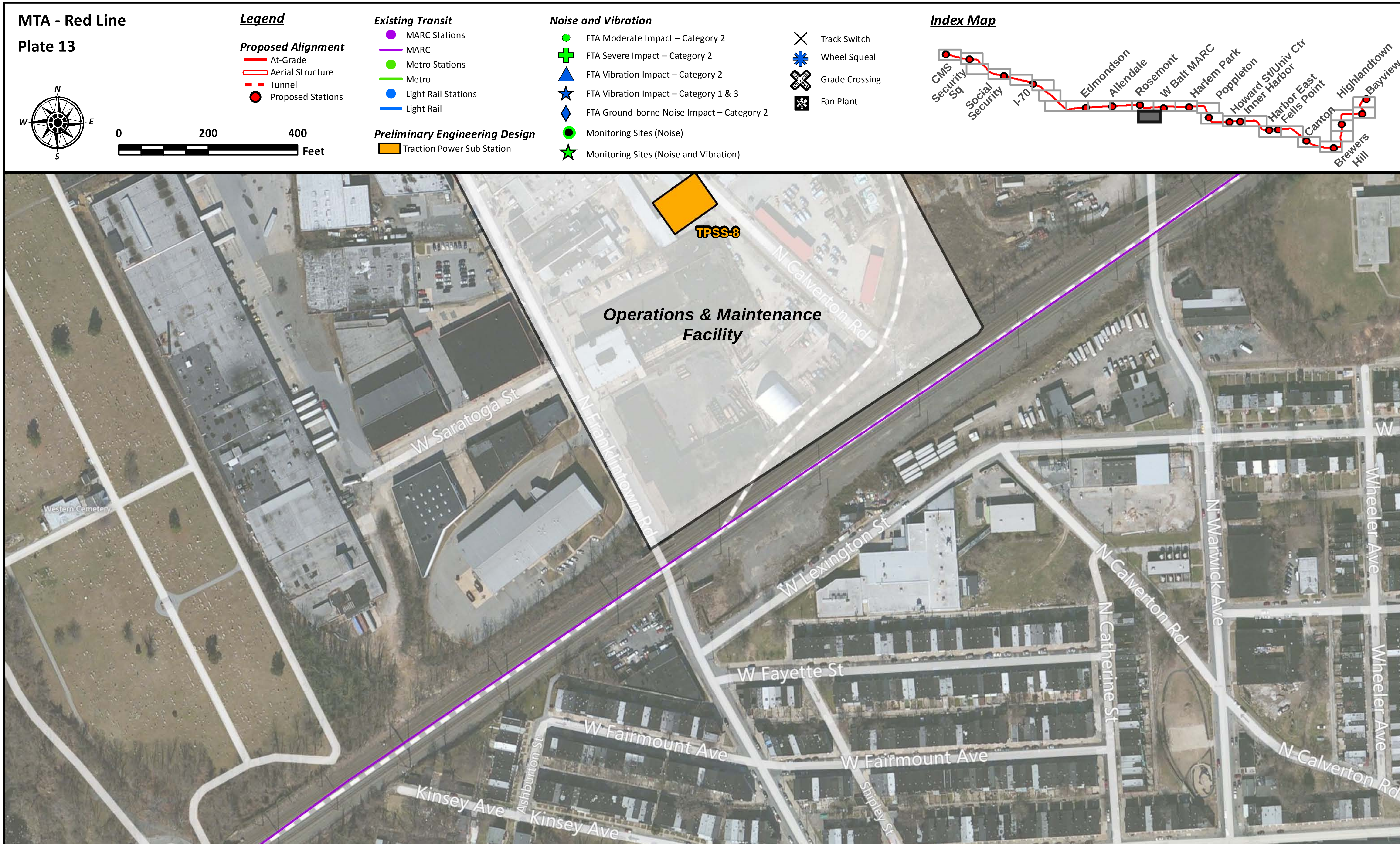


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

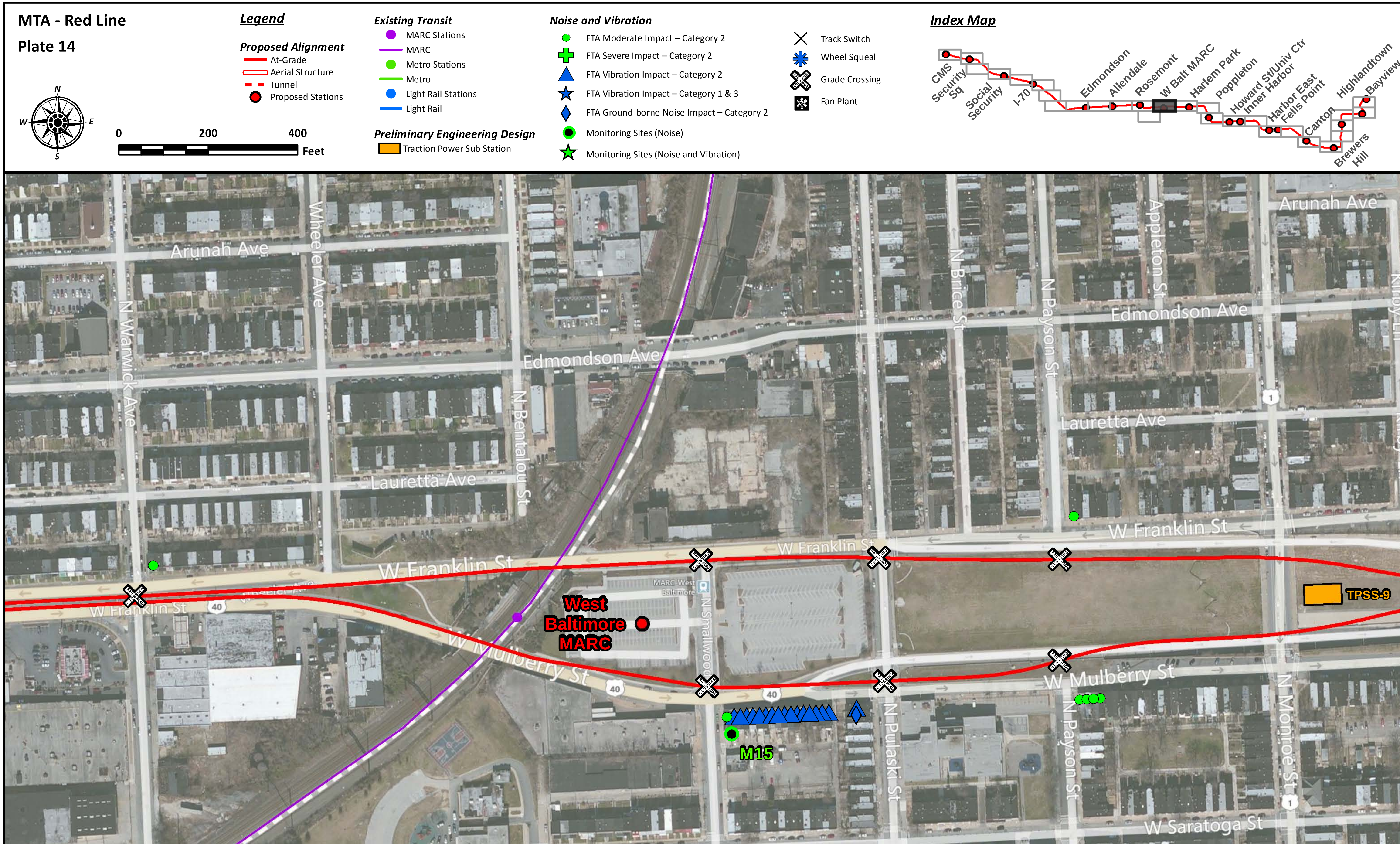


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

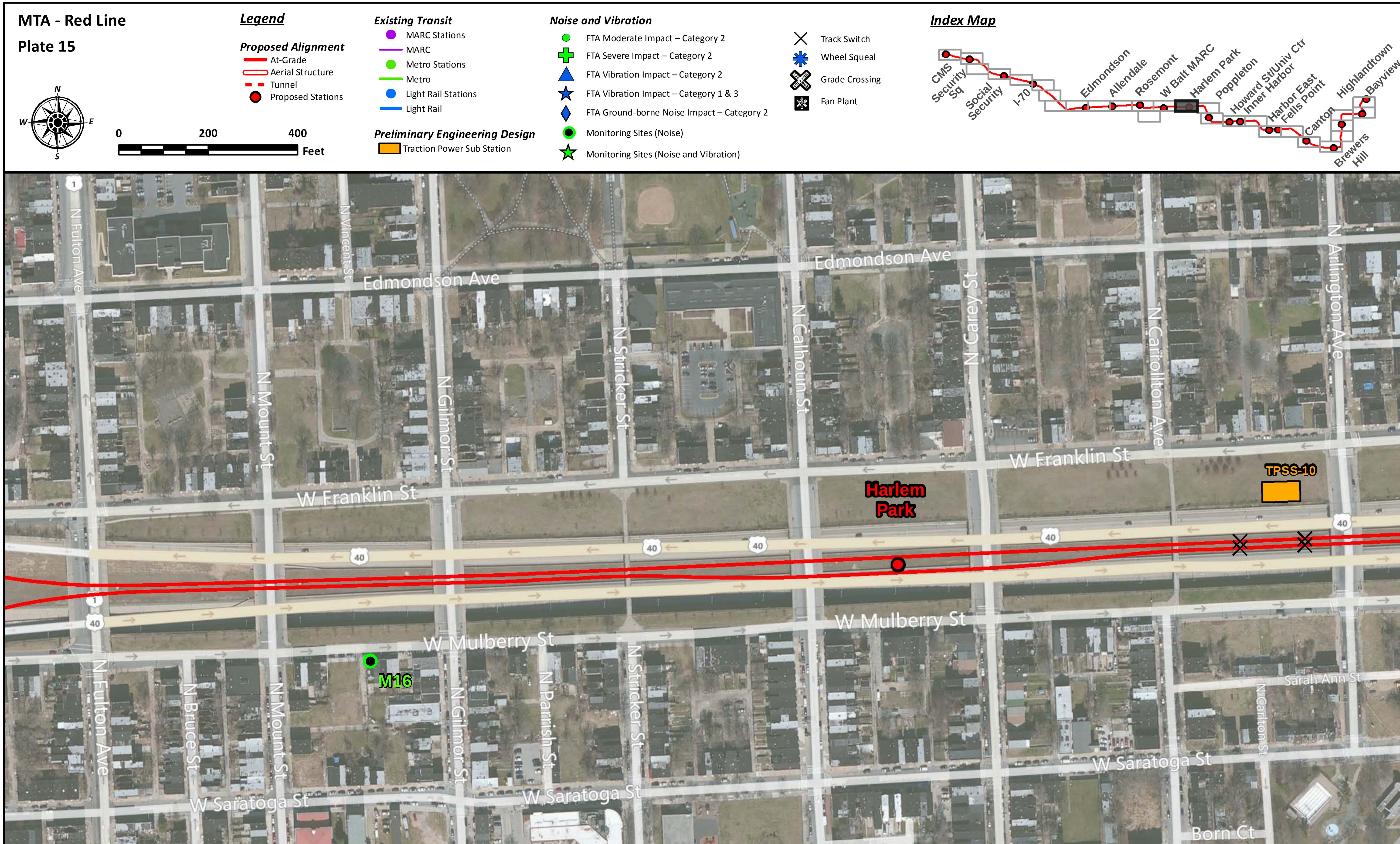


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

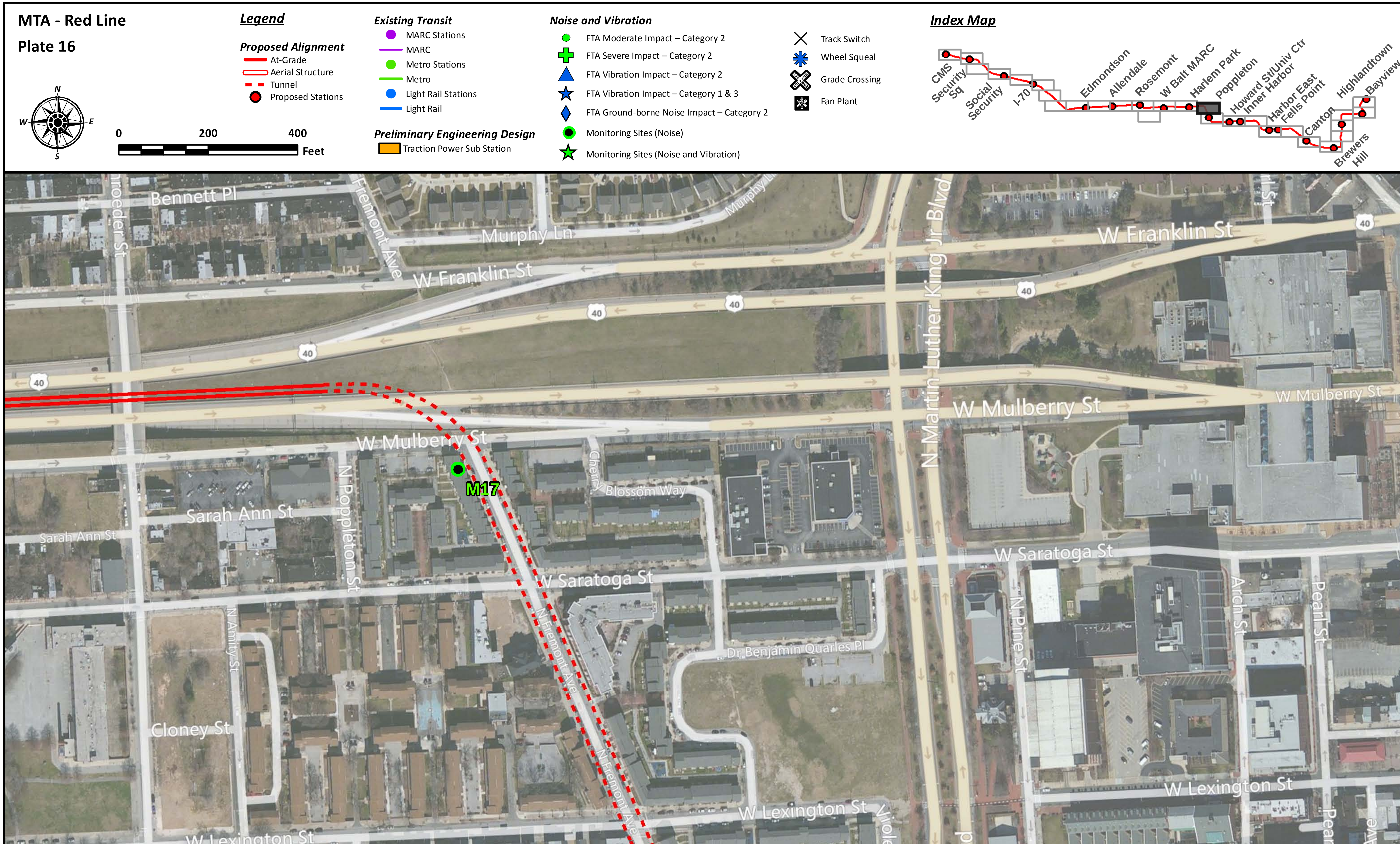


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

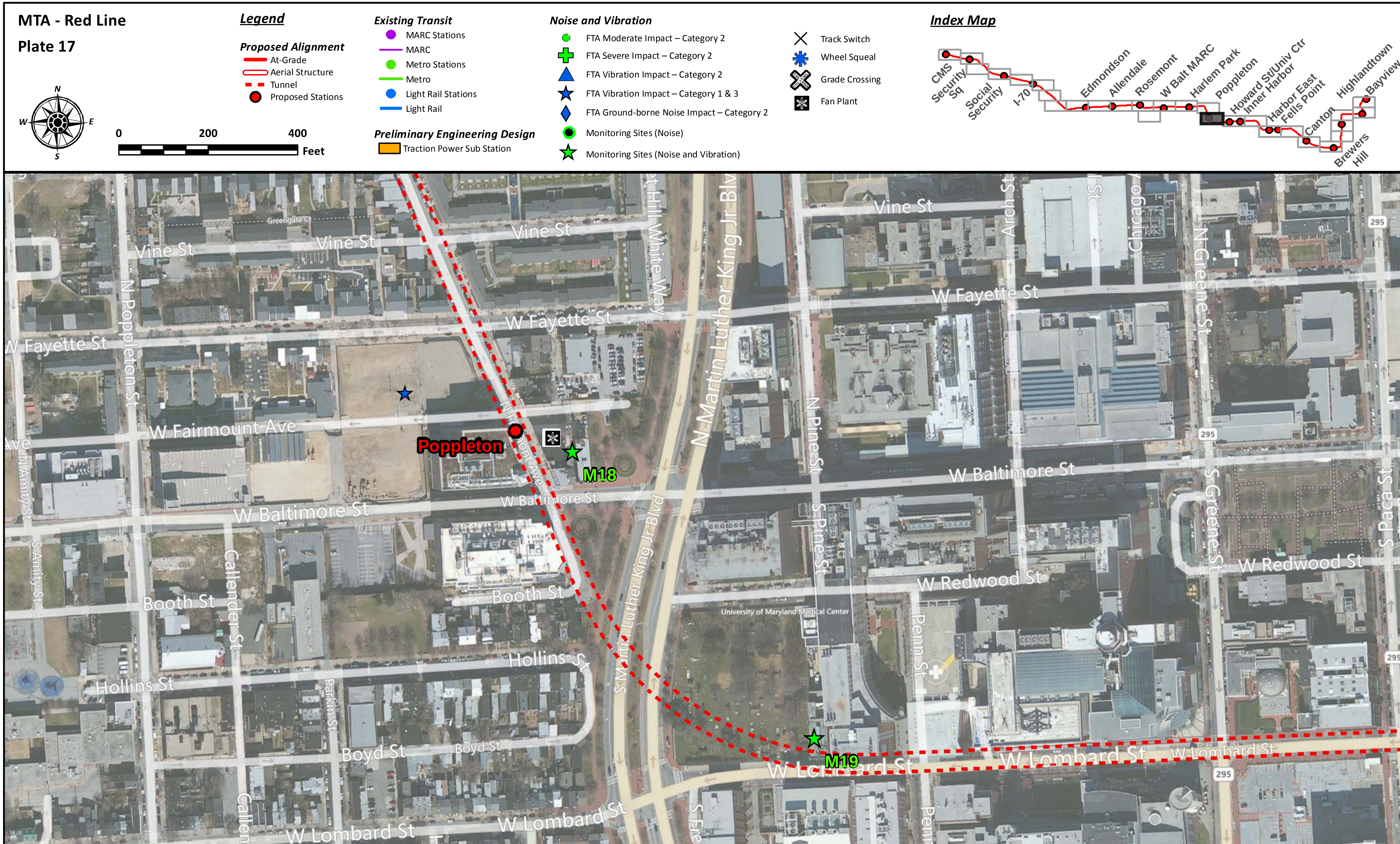


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

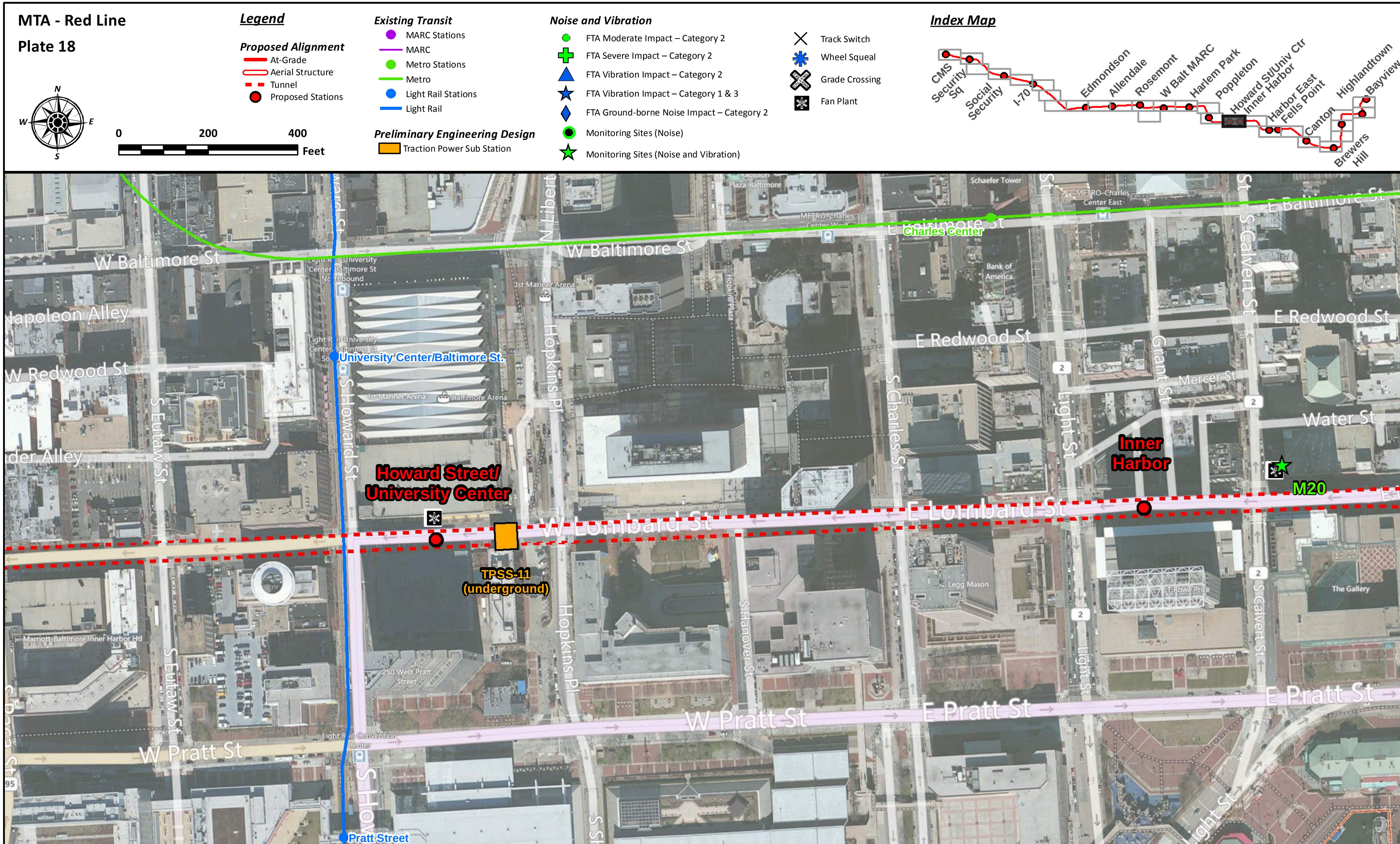


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

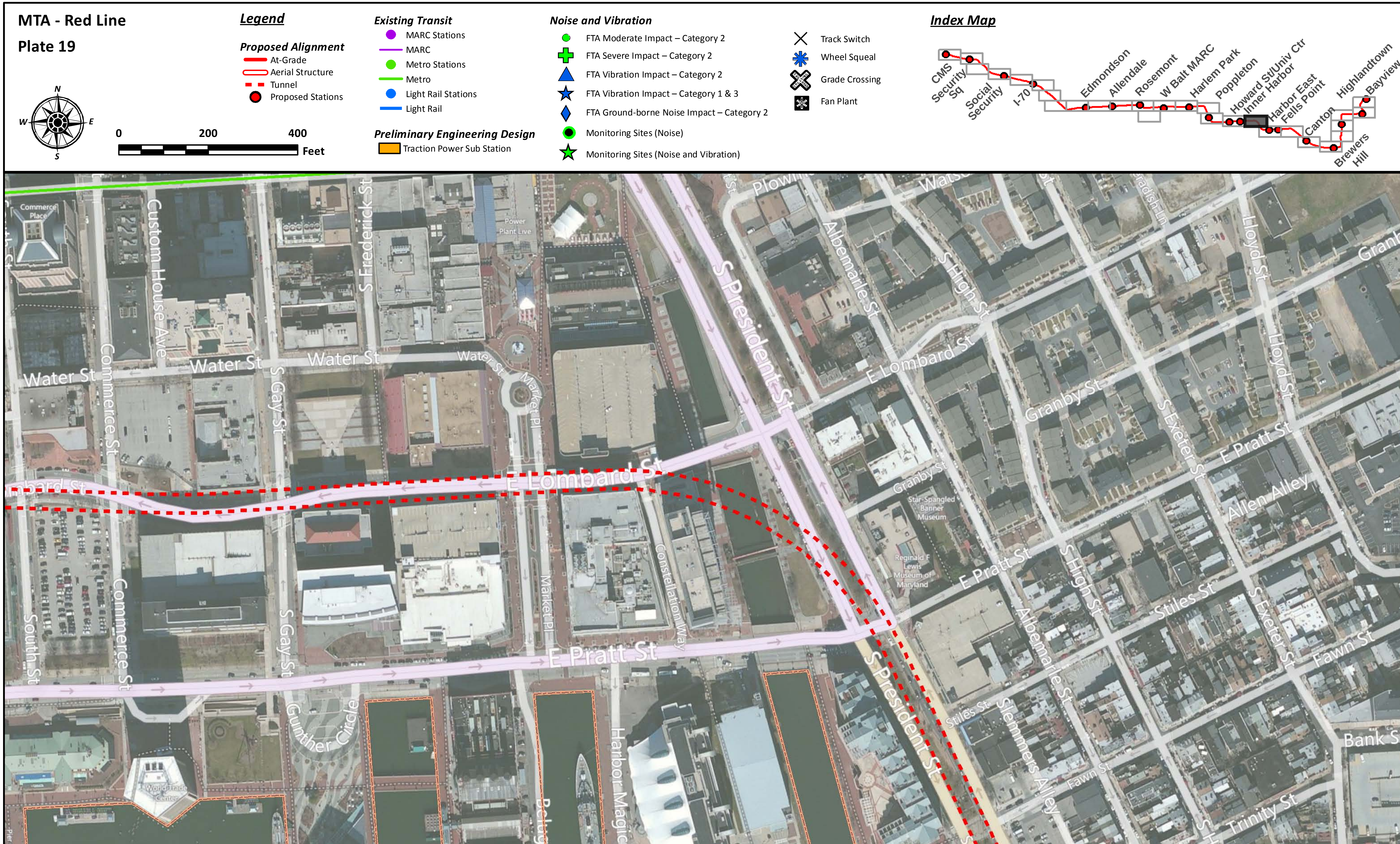


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

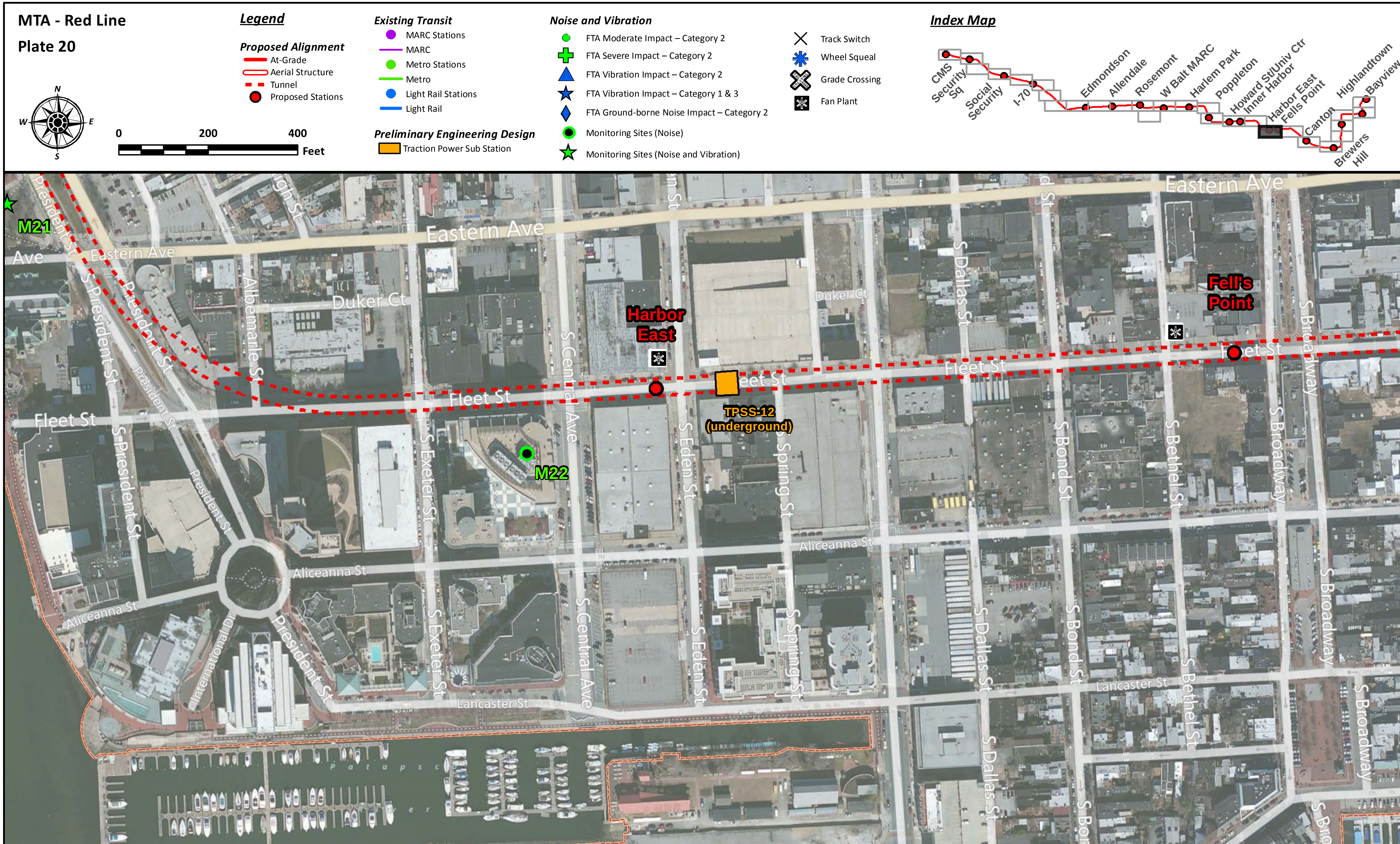


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

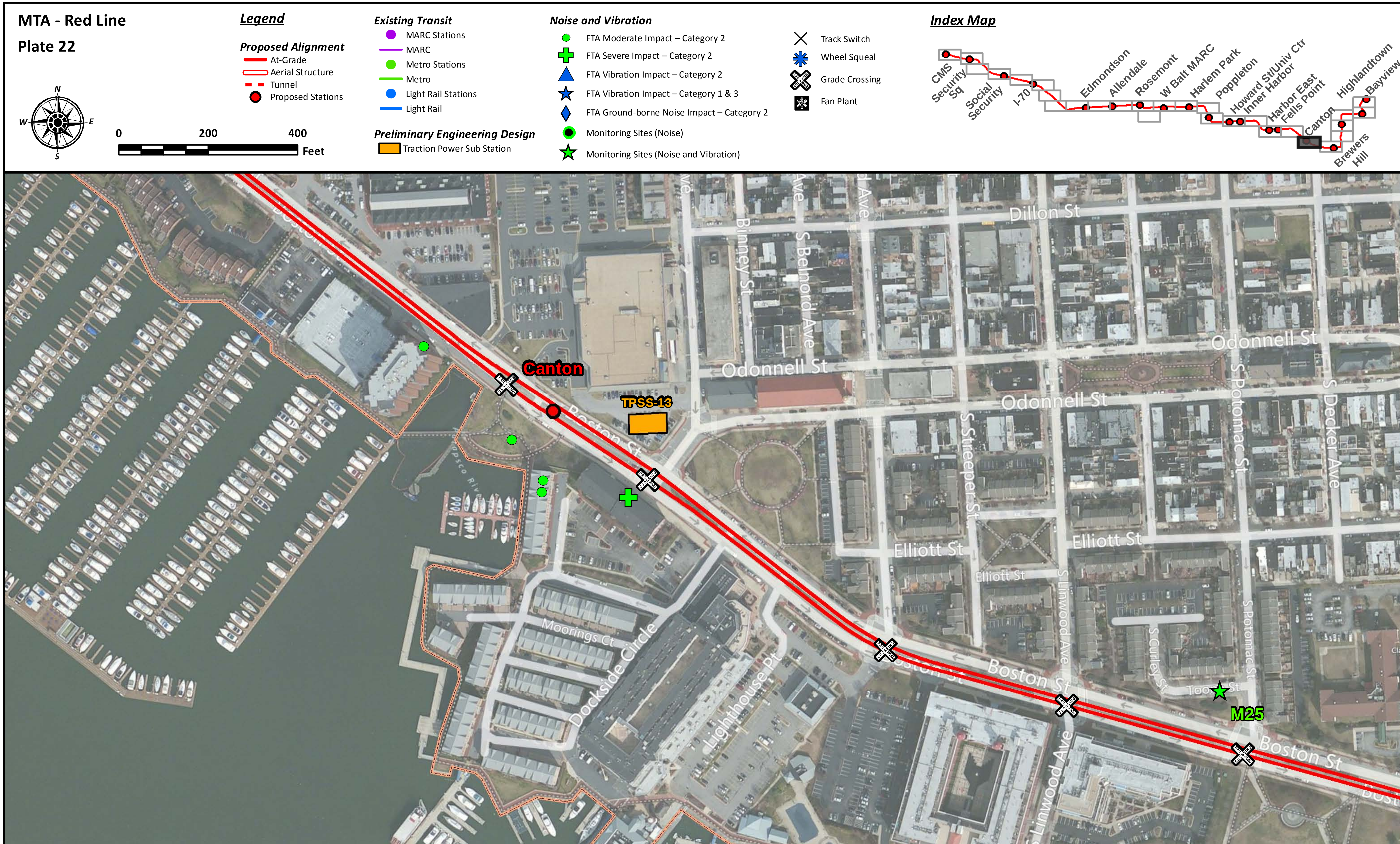


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

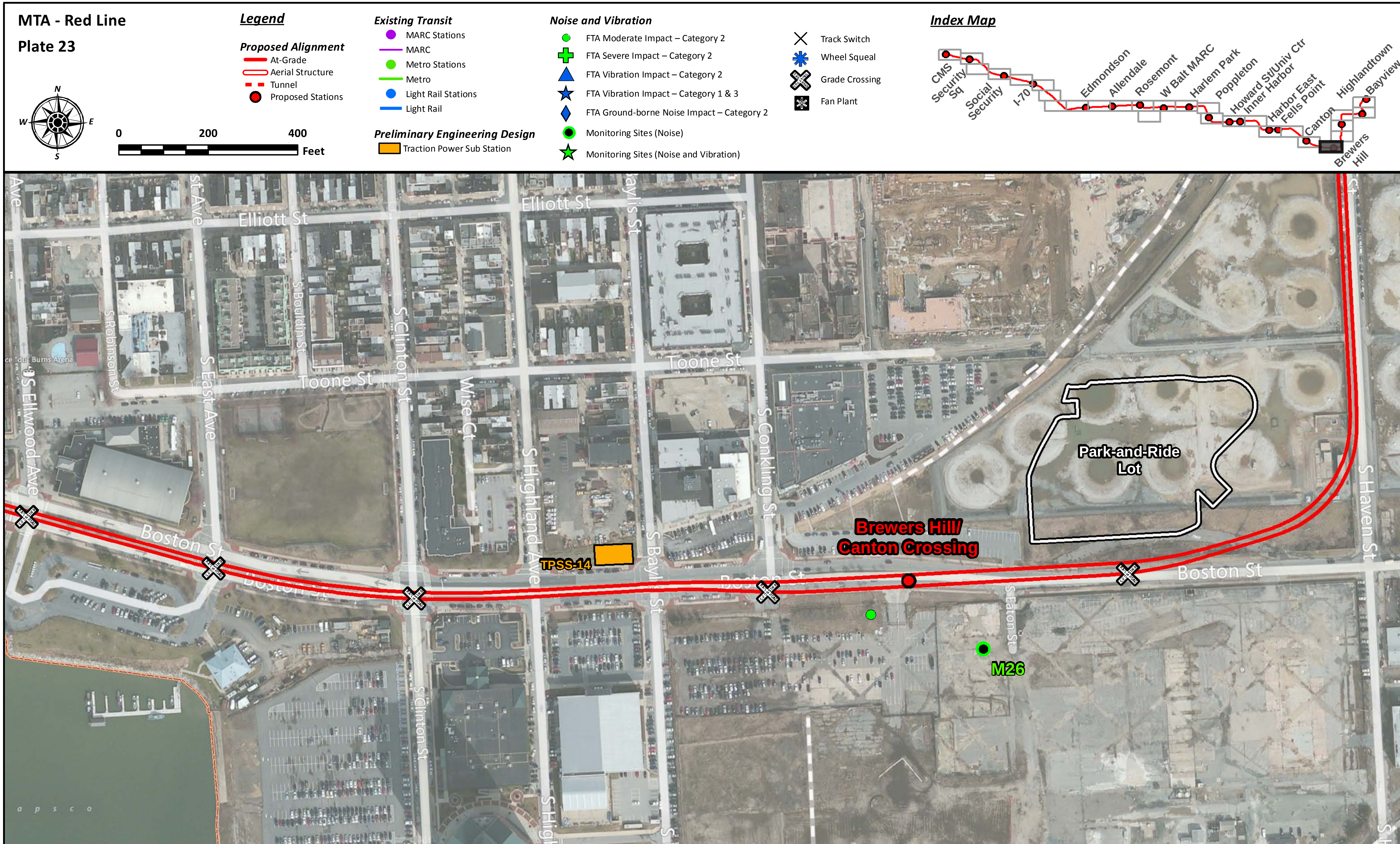


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

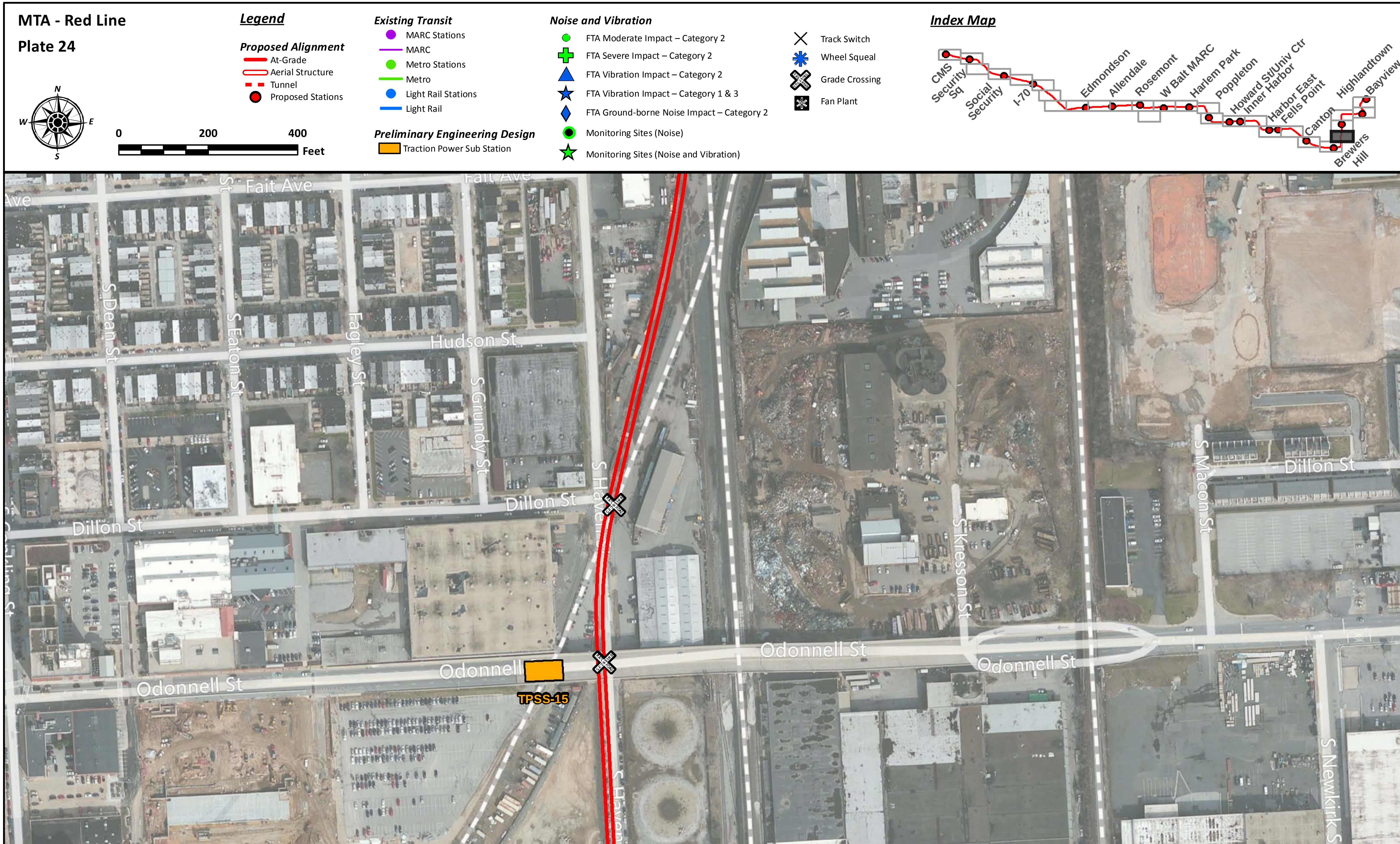


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

MTA - Red Line

Plate 26

Legend

Proposed Alignment
- At-Grade
- Aerial Structure
- Tunnel
- Proposed Stations

Existing Transit
- MARC Stations
- MARC
- Metro Stations
- Metro
- Light Rail Stations
- Light Rail

Preliminary Engineering Design
- Traction Power Sub Station

Noise and Vibration
- FTA Moderate Impact – Category 2
- FTA Severe Impact – Category 2
- FTA Vibration Impact – Category 2
- FTA Vibration Impact – Category 1 & 3
- FTA Ground-borne Noise Impact – Category 2
- Monitoring Sites (Noise)
- Monitoring Sites (Noise and Vibration)
- Track Switch
- Wheel Squeal
- Grade Crossing
- Fan Plant

0 200 400 Feet

Index Map

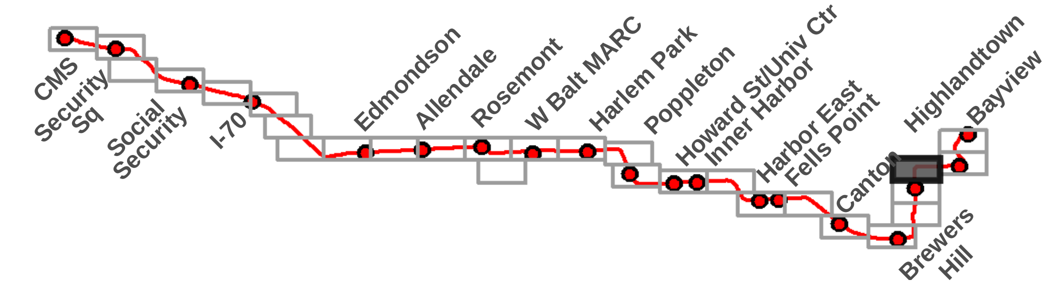


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

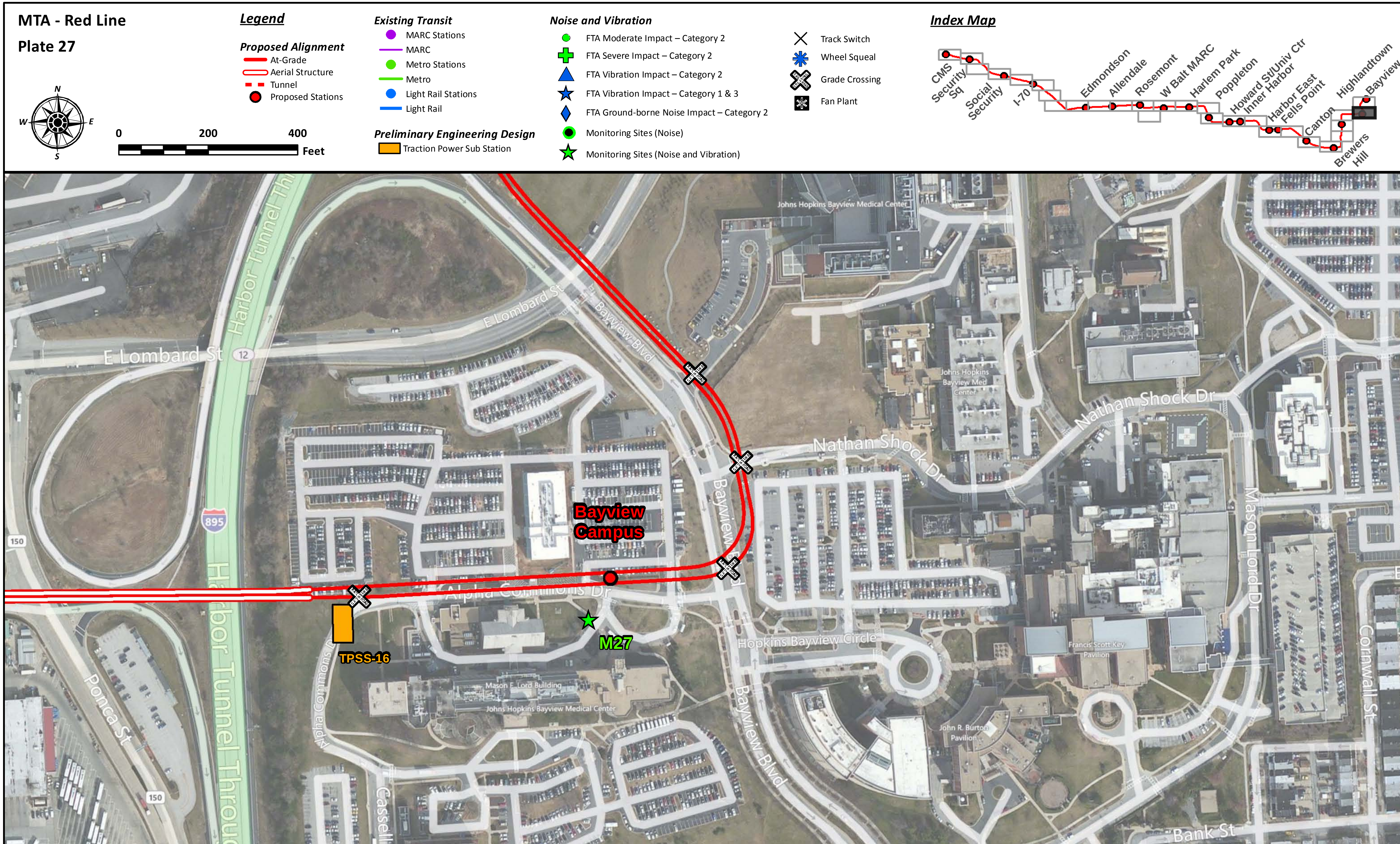


Figure A: Predicted Noise and Vibration Impacts under the Preferred Build Alternative

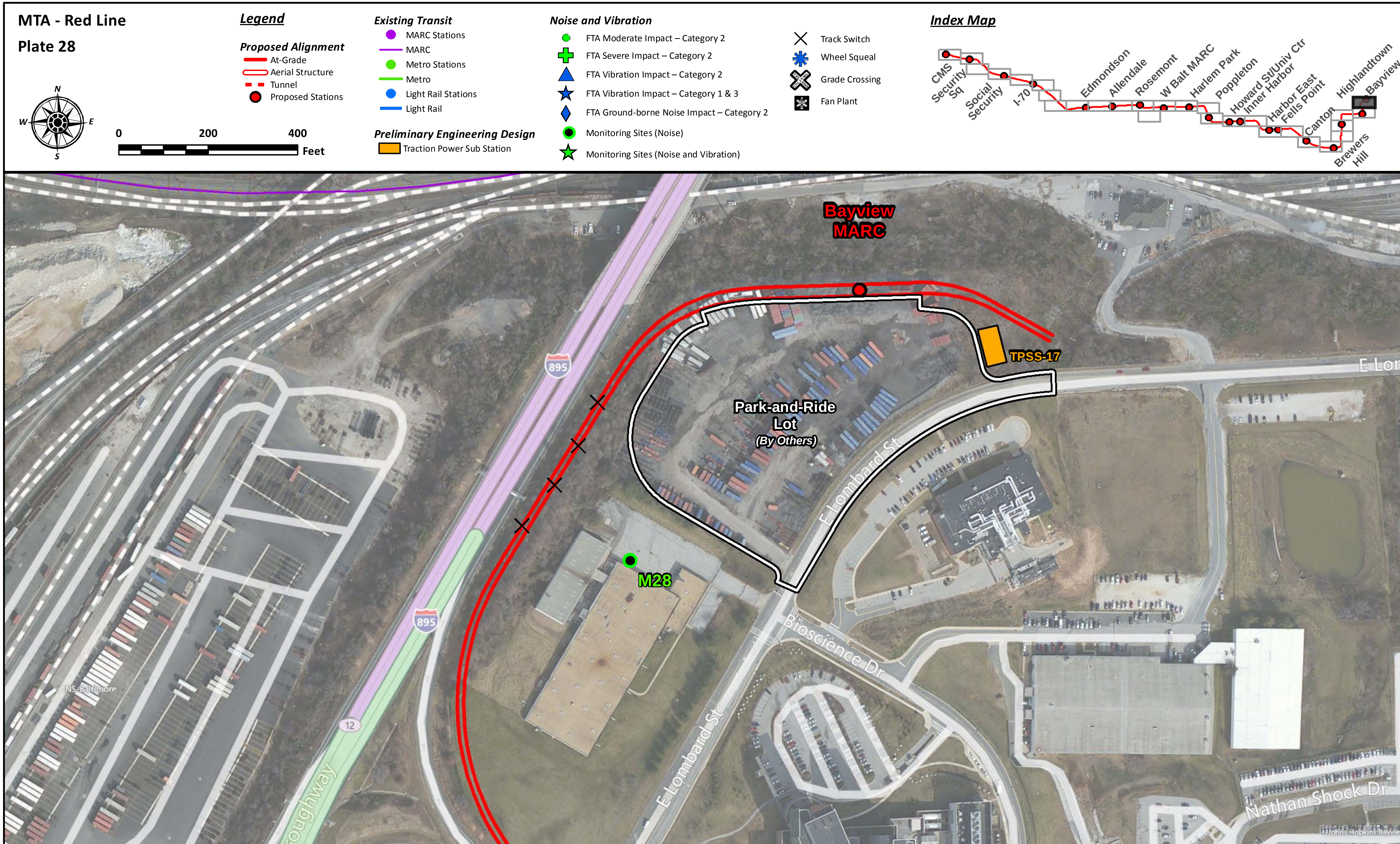


Table A: Expanded Results of the Detailed Construction Noise and Vibration Impact Assessment

Scenario			**Period**		**Duration**	**Hours/**	**50-ft Noise Levels**	
Type	**ID**	**Description**	**Start**	**Finish**	**(months)**	**Month**	**L_{max}**	**L_{eq}(h)**
C01 West Segment								
Surface	11	Mobilization	15-Sep-15	13-Nov-15	1.9	160	88.0	87.8
Surface	12	MPT / Advanced Utility Relocation	16-Nov-15	7-Jun-17	18.4	160	88.0	91.8
Surface	13	1096+00 to 1139+50 Tail Tracks to Belmont Avenue	16-Feb-16	26-Dec-16	10.1	160	88.0	93.2
Surface	14	1139+50 to 1152+00 Belmont Avenue to West of I-695	22-Aug-16	22-Dec-16	3.9	160	88.0	93.2
Surface	15	1152+00 to 1162+00 Bridge over I-695	17-Mar-16	23-Jan-17	10.1	160	101.0	96.9
Surface	16	1162+00 to 1196+00 East of I-695 to SSA Station	17-Mar-16	1-Nov-16	7.4	160	88.0	93.2
Surface	17	1196+00 to 1243+00 East of SSA Station to I-70 Park & Ride	20-Jul-16	10-Apr-17	8.5	160	88.0	93.2
Surface	18	1243+00 to 1250+25 East of I-70 Park & Ride to East of Ingleside Avenue	9-Nov-16	7-Apr-17	4.8	160	88.0	91.1
Surface	19	Demobilization	11-Apr-17	7-Jun-17	1.8	160	85.0	85.5
C02 Cook's Lane Tunnel Segment								
Tunnel	21	Mobilization	30-May-15	26-Jun-15	1.0	320	85.0	85.4
Tunnel	22	Utility Relocation - Relocate Utilities	13-Aug-15	15-Mar-16	7.0	320	85.0	86.0
Tunnel	23	Utility Relocation - Backfill / Restore Streets	19-Jan-18	22-May-18	4.0	320	85.0	87.7
Tunnel	24	West Portal Retained Excavation & Open Cut Construction	29-Jun-15	15-Sep-16	15.0	320	101.0	99.3
Tunnel	25	West Portal Retained Excavation & Open Cut Construction - Concrete Lining	19-Jan-18	19-Jun-18	5.0	320	85.0	86.0
Tunnel	26	East Portal Retained Cut Excavation & Open Cut Construction	27-Nov-15	30-Jan-17	14.0	320	101.0	99.3
Tunnel	27	East Portal Retained Cut Excavation & Open Cut Construction - Concrete Lining	19-Jan-18	19-Jun-18	5.0	320	85.0	86.0
Tunnel	28	Construct Tunnels - Ground Improvement @ Portals	13-Aug-15	12-Feb-16	6.0	480	85.0	88.5
Tunnel	29	Construct Tunnels - C02-1550 Assemble & Test TBM	16-Sep-16	16-Nov-16	2.0	480	88.0	88.1
Tunnel	30	Construct Tunnels - C02-1560 thru C02-1620 TBM Run # 1	17-Nov-16	26-May-17	6.0	480	88.0	91.3
Tunnel	31	Construct Tunnels - C02-1630 Remove / Reassemble TBM & Test	29-May-17	27-Jun-17	1.0	480	88.0	88.1
Tunnel	32	Construct Tunnels - C02-1820 thru C02-1880 TBM Run # 2	28-Jun-17	4-Jan-18	7.0	480	88.0	91.3

Table A: Expanded Results of the Detailed Construction Noise and Vibration Impact Assessment

Scenario			Period		Duration	Hours/	50-ft Noise Levels	
Type	**ID**	**Description**	**Start**	**Finish**	**(months)**	**Month**	**L_{max}**	**L_{eq}(h)**
Tunnel	33	Construct Tunnels - C02-1890 Remove TBM	5-Jan-18	18-Jan-18	1.0	480	88.0	88.1
Tunnel	34	Construct Cross Passages	19-Jan-18	3-Jul-18	6.0	480	88.0	87.8
Tunnel	35	Internal Concrete	19-Jan-18	7-Jun-18	5.0	480	83.0	87.1
Tunnel	36	Demobilization	8-Jun-18	30-Aug-18	2.0	173.3333	85.0	85.4
C03 US 40 Segment								
Surface	31	Mobilization	24-Mar-15	23-Jul-15	3.9	160	85.0	85.5
Surface	32	MPT / Advanced Utility Relocation	25-May-15	25-May-17	23.6	160	88.0	91.1
Surface	33	3007+50 to 3019+00 East of Retained Cut at Uplands Pkwy to Edmondson Village Station	1-Sep-15	16-Feb-16	5.4	160	101.0	96.6
Surface	34	3019+00 to 3059+00 East of Edmondson Village Station to Allendale Street Station	17-Feb-16	9-Aug-16	5.6	160	88.0	93.2
Surface	35	3059+00 to 3098+00 East of Allendale Street Station to Rosemont Station	2-Dec-15	8-Jul-16	7.1	160	88.0	93.2
Surface	36	3098+00 to 3134+00 East of Rosemont Station to West Baltimore MARC Station	11-Jul-16	1-Mar-17	7.5	160	88.0	93.2
Surface	37	3134+00 to 3172+00 East of West Baltimore MARC Station to Harlem Park Station	10-Aug-16	13-Feb-17	6.0	160	88.0	93.2
Surface	38	3172+00 to 3182+00 East of Harlem Park Station to East or Arlington Avenue	14-Feb-17	28-Mar-17	1.4	160	88.0	91.1
Surface	39	Demobilization	29-Mar-17	25-May-17	1.8	160	85.0	85.5
C04 Downtown Tunnel Segment								
Tunnel	41	C04-1020 Mobilization	6-Apr-15	2-Jun-15	2.0	320	85.0	85.4
Tunnel	42	Utility Relocation	3-Jun-15	18-Nov-15	5.0	320	85.0	89.0
Tunnel	43	West Portal Retained Excavation & Open Cut Construction C04-4265 thru C04-4280	20-Oct-15	14-Jun-16	8.0	320	101.0	99.3
Tunnel	44	West Portal Retained Cut Excavation & Open Cut Construction C04-4300 Concrete Lining	18-Oct-18	20-Mar-19	5.0	480	85.0	86.0
Tunnel	45	East Portal Retained Cut Excavation & Open Cut Construction C04-4275 thru C04-9070	19-Nov-15	25-May-17	18.0	480	101.0	99.3

Table A: Expanded Results of the Detailed Construction Noise and Vibration Impact Assessment

Scenario			Period		Duration	Hours/	50-ft Noise Levels	
Type	ID	Description	Start	Finish	(months)	Month	L_{max}	$L_{eq}(h)$
Tunnel	46	East Portal Retained Cut Excavation & Open Cut Construction C04-9075 Concrete Lining	18-Oct-18	20-Mar-19	5.0	480	101.0	86.0
Tunnel	47	Construct Tunnels - C04-5010 Drill & Shoot Starter Tunnels	15-Jun-16	30-Jun-16	1.0	480	88.0	10.0
Tunnel	48	Construct Tunnels - C04-5020 Assemble & Test TBM 1 & 2, Trailing Gear, Rail Equipment	4-Aug-16	2-Sep-16	1.0	480	88.0	90.5
Tunnel	49	Construct Tunnels - C04-5030 thru C04-5160 TBM Run #1	5-Sep-16	3-Jul-18	22.0	480	88.0	91.3
Tunnel	50	Construct Tunnels - C04-5170 Remove TBM # 1	4-Jul-18	17-Jul-18	1.0	480	88.0	88.1
Tunnel	51	Construct Tunnels - C04-5172 Contingency TBM Run 1 Howard St to East End	18-Jul-18	17-Oct-18	3.0	480	88.0	91.3
Tunnel	52	Construct Tunnels - C04-5180 thru C04-5310 TBM Run # 2	29-Sep-16	3-Jul-18	22.0	480	88.0	91.3
Tunnel	53	Construct Tunnels - C04-5180 thru C04-5320 Remove TBM # 2	4-Jul-18	17-Jul-18	1.0	480	88.0	88.1
Tunnel	54	Construct Tunnels - C04-5322 Contingency TBM Run 2 Howard St to East End	18-Jul-18	17-Oct-18	3.0	480	88.0	91.3
Tunnel	55	Internal Concrete	18-Oct-18	25-Jun-19	8.0	480	85.0	87.1
Tunnel	56	Construct Cross Passages	18-Oct-18	20-Jun-19	8.0	480	88.0	87.8
Tunnel	57	Demobilization - Final Tunnel Cleanup C04-9045	18-Oct-18	31-Oct-18	1.0	480	85.0	85.4
Tunnel	58	Demobilization C04-9065	26-Jun-19	22-Aug-19	2.0	480	85.0	85.4
C04A Downtown Tunnel Stations								
Tunnel	41	C04-1020 Mobilization	7-Jul-15	6-Dec-17	29.0	320	85.0	90.8
Tunnel	42	Utility Relocation	22-Oct-15	11-Apr-17	18.0	320	88.0	93.5
Tunnel	43	West Portal Retained Excavation & Open Cut Construction C04-4265 thru C04-4280	22-Oct-15	24-May-16	7.0	160	85.0	87.2
Tunnel	44	West Portal Retained Cut Excavation & Open Cut Construction C04-4300 Concrete Lining	25-Feb-16	10-Oct-17	20.0	480	88.0	95.5
Tunnel	45	East Portal Retained Cut Excavation & Open Cut Construction C04-4275 thru C04-9070	7-Sep-15	13-Jun-17	21.0	480	101.0	99.0
Tunnel	46	East Portal Retained Cut Excavation & Open Cut Construction C04-9075 Concrete Lining	7-Sep-15	6-Jan-16	4.0	480	88.0	95.5
Tunnel	47	Construct Tunnels - C04-5010 Drill & Shoot Starter Tunnels	18-Oct-16	22-Jan-18	15.0	480	88.0	95.5
Tunnel	48	Construct Tunnels - C04-5020 Assemble & Test TBM 1 & 2,	23-Jan-18	21-Mar-18	2.0	173.3333	85.0	85.4

Table A: Expanded Results of the Detailed Construction Noise and Vibration Impact Assessment

Scenario			Period		Duration	Hours/	50-ft Noise Levels	
Type	**ID**	**Description**	**Start**	**Finish**	**(months)**	**Month**	L_{max}	$L_{eq}(h)$
		Trailing Gear, Rail Equipment						
C04B Downtown Tunnel Stations								
Tunnel	41	C04-1020 Mobilization	12-Jun-16	5-Sep-17	15.0	320	85.0	85.4
Tunnel	42	Utility Relocation	1-Nov-18	25-Dec-19	13.0	320	85.0	93.4
Tunnel	43	West Portal Retained Excavation & Open Cut Construction C04-4265 thru C04-4280	23-Oct-17	29-Apr-19	18.0	320	85.0	93.4
Tunnel	44	West Portal Retained Cut Excavation & Open Cut Construction C04-4300 Concrete Lining	26-Dec-19	21-Feb-20	2.0	173.3333	85.0	85.4
C05 East Segment								
Surface	51	Mobilization	2-Jun-15	1-Oct-15	3.9	160	85.0	85.5
Surface	52	MPT / Advanced Utility Relocation	3-Aug-15	20-Nov-17	27.1	160	88.0	92.9
Surface	53	5002+00 to 5048+00 East of Tunnel Portal Retained Cut to Canton Crossing Station	10-Nov-15	9-Jun-16	6.8	160	88.0	93.5
Surface	54	5048+00 to 5091+00 East of Canton Crossing Station to Greektown/Highlandtown Station	10-Jun-16	5-Dec-16	5.7	160	88.0	93.5
Surface	55	5091+00 to 5135+00 East of Greektown/Highlandtown Station to Bayview Campus Station	2-Oct-15	7-Apr-17	17.8	160	101.0	97.0
Surface	56	5135+00 to 5170+50 East of Bayview Campus Station to Bayview MARC Station Tail Tracks	23-Jun-16	21-Sep-17	14.7	160	88.0	93.5
Surface	57	Demobilization	22-Sep-17	20-Nov-17	1.9	160	88.0	87.8
C09 Operations and Maintenance Facility								
Surface	91	Mobilization	4-Dec-15	6-Jul-16	6.9	160	88.0	88.6
Surface	92	Yard Construction	7-Mar-16	2-May-18	25.4	160	101.0	96.9
Surface	93	Demobilization	3-May-18	29-Jun-18	1.8	160	88.0	88.6

APPENDIX B
SUPPORT DOCUMENTATION

NIH Vibration Monitoring and Prediction Results[1]

1. Project Description

The study involved performing a series of vibration measurements and tests at the National Institute of Health (NIH) Biomedical Research Center located on the Johns Hopkins Bayview Medical Center campus in Baltimore, MD. The measurements and tests were conducted on May 7th and 8th, 2012. The goal was to collect vibration data that, upon analysis, could determine if vibration levels associated with future Baltimore Red Line transit vehicle operations may or may not adversely impact animal experiments or extremely sensitive devices used inside the NIH building. More specifically, the areas of concern focused on an electron microscope (EM) and magnetic resonance imaging machine (MRI) that are in use in the building's northwest corner of the sub-basement, and a laboratory located in the building's southwest corner of the sub-basement where animal experiments on monkeys and rats are conducted.

Photo 1: NIH Building

The NIH building, as shown in **Photo 1**, is a 13 story building (10 floors above grade, 3 floors below grade) built into a hillside. The building is brick and glass, and is built on a poured concrete foundation with spread footings.

Of particular interest is a massive underground retention wall along the building's southwest corner near the animal lab. It is a 4-foot-wide earth-filled concrete wall that was necessary for support of excavation during construction. There is also a "floating floor" under the EM and MRI in the building's northwest sub-basement corner specifically intended to reduce ambient vibration levels affecting these devices.

2. Technical Approach

The technical approach used to predict future Red Line LRT vibration levels inside the NIH building involved four steps, as described below. The general methodology is similar to the "Detailed Vibration Analysis" method described in the Federal Transit Administration's (FTA) *Transit Noise and Vibration Impact Assessment Manual* (2006).

In all cases, vibration data was collected as (or reduced to) vertical vibration velocity levels in decibels relative to 1 micro-inch/second (i.e. VdB re 1 µ-inch/sec). Vibration data was measured in unweighted third-octave band format over the frequency range of 1 Hz to 100 Hz, and all

[1] This report was prepared by Mr. Erich Thalheimer (Parsons Brinckerhoff) on May 30, 2012.

subsequent prediction modeling was done in third-octave bands to account for the frequency-dependant effects of vibration generation and propagation through the ground and building.

1. *Determine anticipated vibration emission levels at a reference distance of 25 feet from a light rail transit (LRT) vehicle similar to the one expected to be used on the future Baltimore Red Line.*

This was accomplished by using published vibration data from the Central Corridor Light Rail Transit (CCLRT) project in Minneapolis, MN. The CCLRT emission data was collected in 2008 along the Hiawatha Line for a Bombardier FLEXITY Swift low-floor train traveling at different speeds over ballast and tie tracks at a reference distance of 25 feet from the tracks. It is anticipated that a similar train set and track configuration would be used on the future Baltimore Red Line. Comparable source emission vibration data was also collected during this assignment on existing MTA Baltimore Blue Line trains; but it was determined that using emission data from the CCLRT project from the FLEXITY Swift train would be more appropriate for the present study.

2. *Establish ground propagation vibration reduction characteristics as a function of distance through the actual ground that would separate the future Red Line trains from the NIH building.*

This was accomplished by performing a series of consistent drop-weight impact tests on the lawn-covered ground surrounding the NIH building. The vibration resulting from a 200-pound drop-weight apparatus was measured at distances of 25 feet, 50 feet, 100 feet, 200 feet and 300 feet. Based on the resulting data, the attenuation of vibration as a function of distance was then computed and normalized to apply as adjustment factors for different distances compared to a reference distance of 25 feet.

3. *Establish building coupling transmissibility loss (attenuation) as vibration passes from outside to inside the NIH building.*

This was accomplished by using the 200-pound drop-weight apparatus at a fixed position proximate to the NIH building's exterior and measuring the resulting vibration levels on the ground immediately adjacent to the building's exterior wall and on the basement floor inside the building immediately adjacent to the same wall. This process had to be performed in two locations because of the building's different foundation conditions affecting the EM and MRI devices versus the animal laboratory area.

4. *Predict vibration levels inside the NIH building and evaluate the results for the sensitive devices and the animal laboratory in accordance with FTA vibration criteria, manufacturer recommendations, and existing ambient vibration conditions.*

This was accomplished by simply adding the results of Steps 1, 2 and 3 together to yield the predicted vibration levels anticipated to occur inside the NIH building because of LRT operations. Two areas of the building were analyzed, namely the area housing the EM and MRI devices and the area housing the animal laboratory. The results were then evaluated using FTA-recommended VC curve criteria for sensitive devices, and the manufacturer's recommended limit of 300 micro-inches/second (i.e. 50 VdB) for the electron microscope. Finally, the predicted results were compared against existing ambient vibration levels measured in close proximity to the EM and MRI devices as well as in the animal laboratory area.

3. Relevant Vibration Criteria

One well-accepted set of vibration criteria originated with the Institute of Environmental Sciences and Technology (IEST) and were published in their Standards RP-CC012.2 and RP-CC024. This family of vibration criterion curves, shown in **Figure 2**, is intended to protect sensitive devices from excessive vibration. The Federal Transit Administration (FTA) subsequently adopted and recommended these criteria in their FTA Transit Noise and Vibration Impact Assessment Manual (May 2006). The FTA Manual only shows VC curves down to VC-E (i.e. 125 micro-inches/second, or 42 VdB), however the curves can be extended lower to VC-F and VC-G as well. In general, each lower VC curve represents half the vibration velocity level of the one above it. **Table 1** provides the vibration velocity levels for each VC curve expressed in engineering units and decibels and a description for the intended use of each criterion curve.

In addition, the manufacturer of the electron microscope provided a recommended ambient vibration specification limit, as relayed through NIH staff, of 300 micro-inches/second (i.e. 50 VdB). Finally, it would be appropriate to compare future predicted Red Line vibration levels with existing ambient vibration levels that currently affect EM and MRI devices and the animal laboratory area. The sensitive devices and animal experiments are being successfully operated and performed today. Thus, it can be reasonably assumed that these activities would remain unaffected by future Red Line LRT vibration provided that the vibration levels remain less than current ambient levels.

Table 1: FTA VC Vibration Criteria Limits and Intended Use

VC Curve Name	Vibration Limit		Intended Use
	Micro-inch/second	VdB re 1 μ-inch/sec	
VC-A	2,000	66	Adequate for medium- to high-power optical microscopes (400X), microbalances, optical balances, and similar specialized equipment.
VC-B	1,000	60	Adequate for high-power optical microscopes (1000X), inspection and lithography equipment to 3 micron line widths.
VC-C	500	54	Appropriate for most lithography and inspection equipment to 1 micron detail size.
VC-D	250	48	Suitable in most instances for the most demanding equipment, including electron microscopes operating to the limits of their capability.
VC-E	125	42	The most demanding criterion for extremely sensitive equipment.

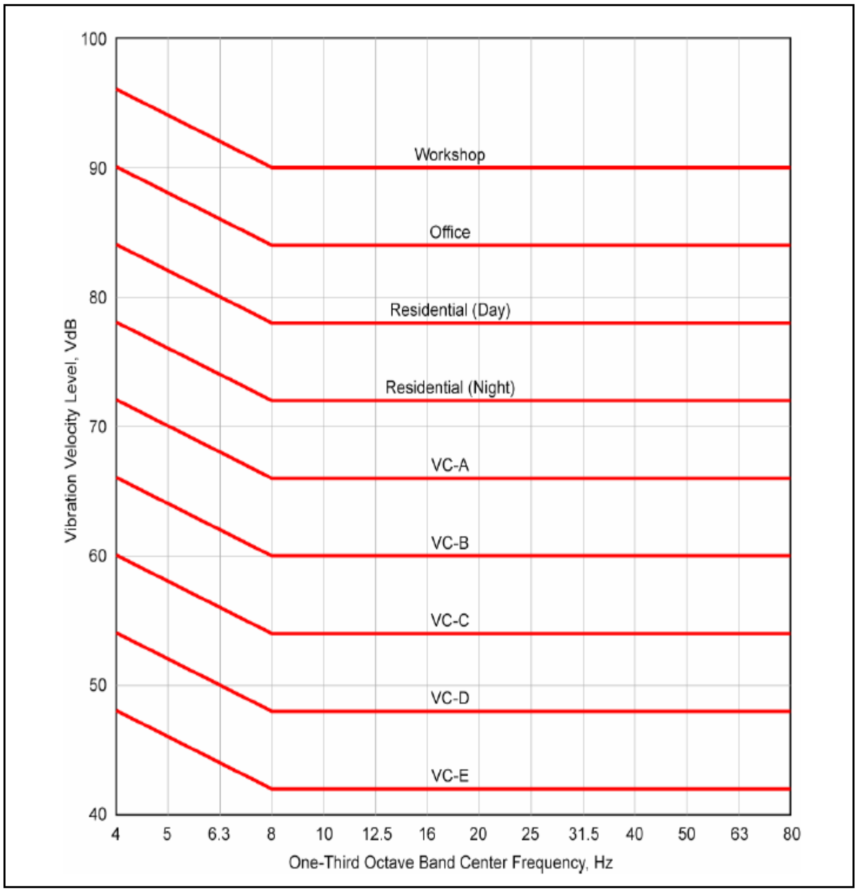


Figure 2: Vibration Criteria (VC) Curves for Sensitive Devices

4. Vibration Measurement Equipment

For this study a portable vibration monitoring and data recording system, as listed in **Table 2** and shown in **Photo 2**, was configured using a high sensitivity PCB 393B05 accelerometer (nominal 10 V/g) as a transducer. The accelerometer's signal was conditioned using a PCB 480E09 signal conditioner, channeled through a B&K ZR0020 adaptor and input to a CEL 593 Analyzer which was set to an RMS 'slow' time response in accordance with FTA Manual recommendations. The CEL 593 allowed for optimization of the signal's dynamic range which was then output to a Marantz PMD670 solid state recorder. The recorded signals (wav files) were later analyzed using SpectraPLUS software to yield vibration acceleration levels for third-octave bands ranging from 1 Hz to 100 Hz. The third-octave band acceleration spectra were then imported into MS Excel spreadsheets for further data reduction, integration to vibration velocity levels, trend curve fitting, summation of broadband VdB results and final presentation.

The PCB 393B05 accelerometer was magnetically attached to a custom-made 35-pound steel mounting cube to facilitate good coupling connection to various kinds of surfaces. This mounting method is recommended in the FTA Manual. A picture of the accelerometer and the mounting cube ready for a measurement in the lawn can be seen in **Photo 3**.

The PCB 393B05 accelerometer is too sensitive to be calibrated by a typical hand-held field calibrator. Therefore, its published sensitivity was used in a comparison calibration method with the results obtained from a less-sensitive Endevco 7703A-1000 accelerometer mounted on a PCB 394C06 vibration calibrator which produces 1 g RMS. This method allowed for proper calibration of the entire vibration data collection and analysis system.

Table 2: Vibration Measurement Instrumentation

Manufacturer	Model	Description
CEL Instruments	CEL593.C1T/2M	Noise and Vibration Analyzer, ANSI Type 1
Bruel & Kjaer	ZR0020	Accelerometer Input Adaptor for SLM
PCB Piezotronics	394C06	Vibration Calibrator, 1.0 g RMS at 159.2 Hz
PCB Piezotronics	480E09	Signal Conditioner, x1, x10, x100 gain
PCB Piezotronics	422E13	Charge Amplifier Converter, 1pC to 1mV
PCB Piezotronics	393B05	Accelerometer, 9870 mV/g
Endevco	7703A-1000	Accelerometer, 981.3 pC/g, 981.3 mV/g
Marantz	PMD670	Solid State Data Recorder (wav files)
Pioneer Hill Software	SpectraPLUS 5.0	FFT & RTA Spectral Analysis PC Software

Photo 2: Vibration Data Collection System

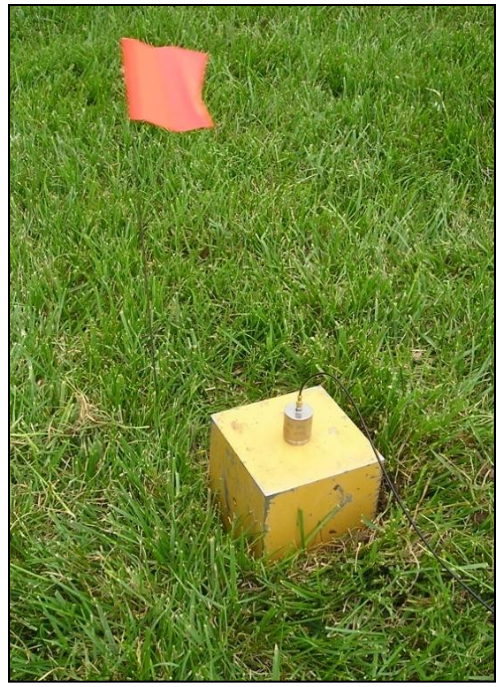


Photo 3: Accelerometer and Mounting Cube

A heavy drop-weight apparatus, as shown in **Photo 4**, was fabricated by AECOM to allow for repetitive generation of vibration impulses. Impulses are useful signals because they excite vibration energy in all frequency bands simultaneously. Eight 25-pound barbell weights were cinched together with a long Eye-bolt to form an essentially solid 200-pound mass. The mass was then lifted via a hand-cranked winch on a heavy tripod to a height of 4 feet above the ground, and then released upon command when a given test was ready to be conducted. The apparatus produced sufficient vibration energy to yield good signal-to-noise ratios at distances as far away as 300 feet from the drop-weight position.

Photo 4: 200 Pound Drop-Weight Apparatus

5. LRT Source Vibration Emission Levels

For the first step in the analysis process, LRT passby vibration emission data was reviewed for potential use as source emission levels in this study. Vibration emission data for a Bombardier FLEXITY Swift low-floor train traveling at different speeds over ballast and tie tracks was collected by ATS Consulting in 2008 along the Hiawatha Line as part of the Central Corridor Light Rail Transit (CCLRT) project in Minneapolis, MN. The CCLRT emission data was collected at train speeds including 20 mph, 30 mph, 40 mph and 50 mph. The results at a reference distance of 25 feet from the track's centerline can be seen in **Figure 2** (solid lines).

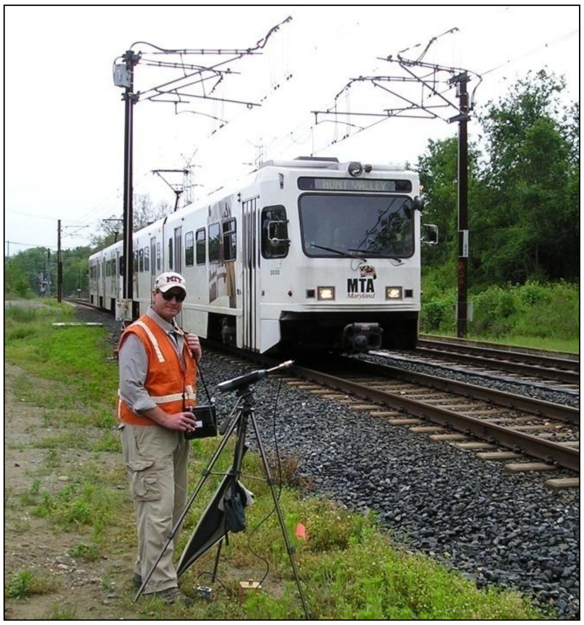


Photo 5: MTA Passby Vibration Measurements

Comparable source emission vibration data was also collected during this assignment on existing MTA Baltimore Blue Line trains, as shown in **Photo 5**. Vibration emission data from eight MTA train passbys were collected at speeds ranging from 28 mph to 45 mph. These data are also shown in **Figure 3** (dashed lines) for comparison to the CCLRT train vibration data. As can be seen, there is excellent agreement between the two sets of vibration data; giving credibility to the use of either set for this study. But it was determined that emission data from the CCLRT project would be better to use as it involved the Bombardier FLEXITY Swift train which is anticipated to be the train set used on the future Baltimore Red Line. Moreover, the CCLRT vibration levels were slightly higher overall at 63 Hz and above, so using it would yield conservative (i.e. worst-case) vibration predictions for this NIH study.

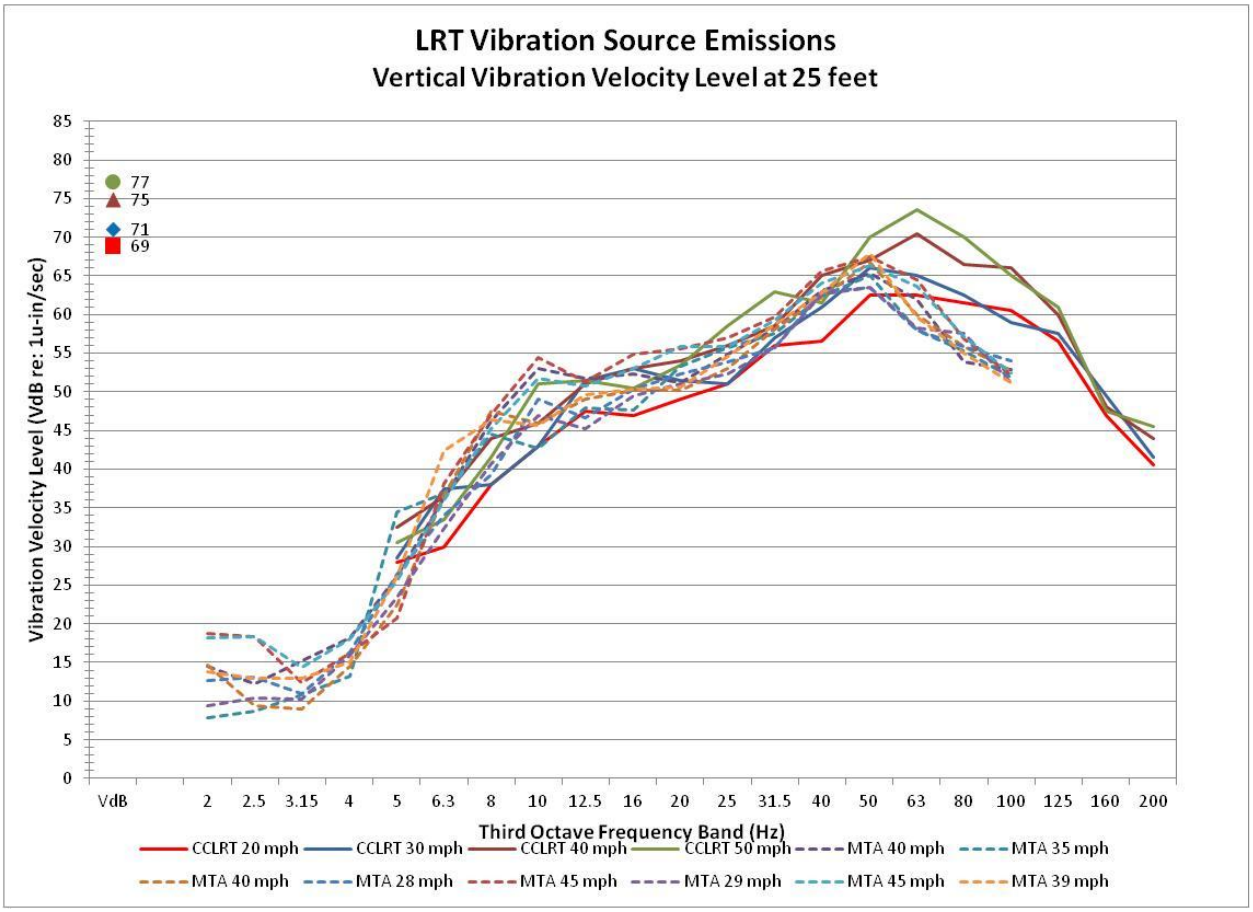


Figure 3: LRT Train Vibration Emission Levels at 25 Feet

6. Ground Propagation Test

The next step in the analysis required performing a series of drop-weight tests on the lawn surrounding the NIH building in order to measure the vibration reduction characteristics through the ground.

Photo 6: Ground Propagation Tests

As shown in **Photo 6**, the 200-pound drop-weight apparatus was positioned at one end of the lawn and a traverse line of measurements points was laid out at distances of 25 feet, 50 feet, 100 feet, 200 feet and 300 feet. The weight was then dropped several times and the resulting vibration impulse levels were measured at each test point. Care was taken to ensure repeatable data results, and 6 to 8 measurements were performed at each distance to allow for statistical averaging of the results.

The resulting average third-octave band vibration velocity levels can be seen in **Figure 4** for various distances from the drop-weight. The broadband VdB levels are also shown in the figure and confirm the expected trend of reduced vibration levels with increasing distance. The absolute levels are not important; rather it is the relative differences in vibration levels from point to point, when normalized to a distance of 25 feet as a reference, which would be used in the vibration propagation model.

The ground propagation portion of the model must be analyzed on a frequency basis in order to properly predict vibration behavior through the ground. Therefore, the results shown in **Figure 5** were generated by plotting the measured vibration levels for each individual third-octave band as a function of distance. By doing so, a logarithmic curve fitting routine (i.e. trend line) could be used to establish mathematical propagation functions for each third-octave band. The resulting equations, in general, showed good curve fit correlation. This is illustrated by the equation for broadband VdB levels at the top of **Figure 5** which produced a coefficient of determination (R^2) of 0.93, or nearly a perfect fit.

In this prediction method, the key to using the third-octave band ground vibration loss factors is to normalize each equation to a reference distance of 25 feet. This is done by first calculating the absolute vibration level at 25 feet using the original equations shown in **Figure 5**, and then subtracting that value from the constant at the end of the equations. Once this change is made, the 25 foot reference distance for the equation now matches the reference distance of the train set's source emission levels. The equations are then used as distance adjustment factors for the calculation of ground attenuation at distances beyond 25 feet from the source.

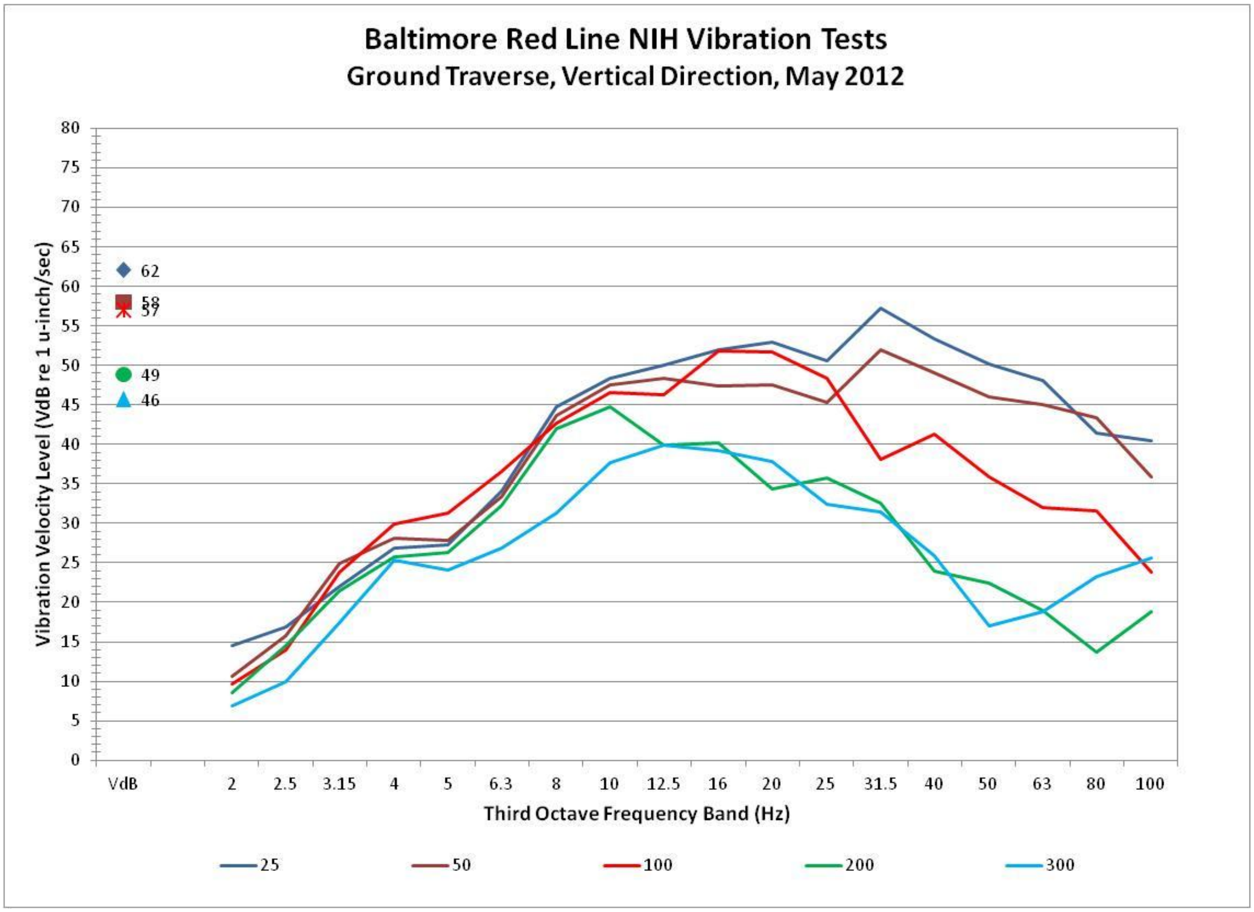


Figure 4: Ground Propagation Vibration Levels at Various Distances

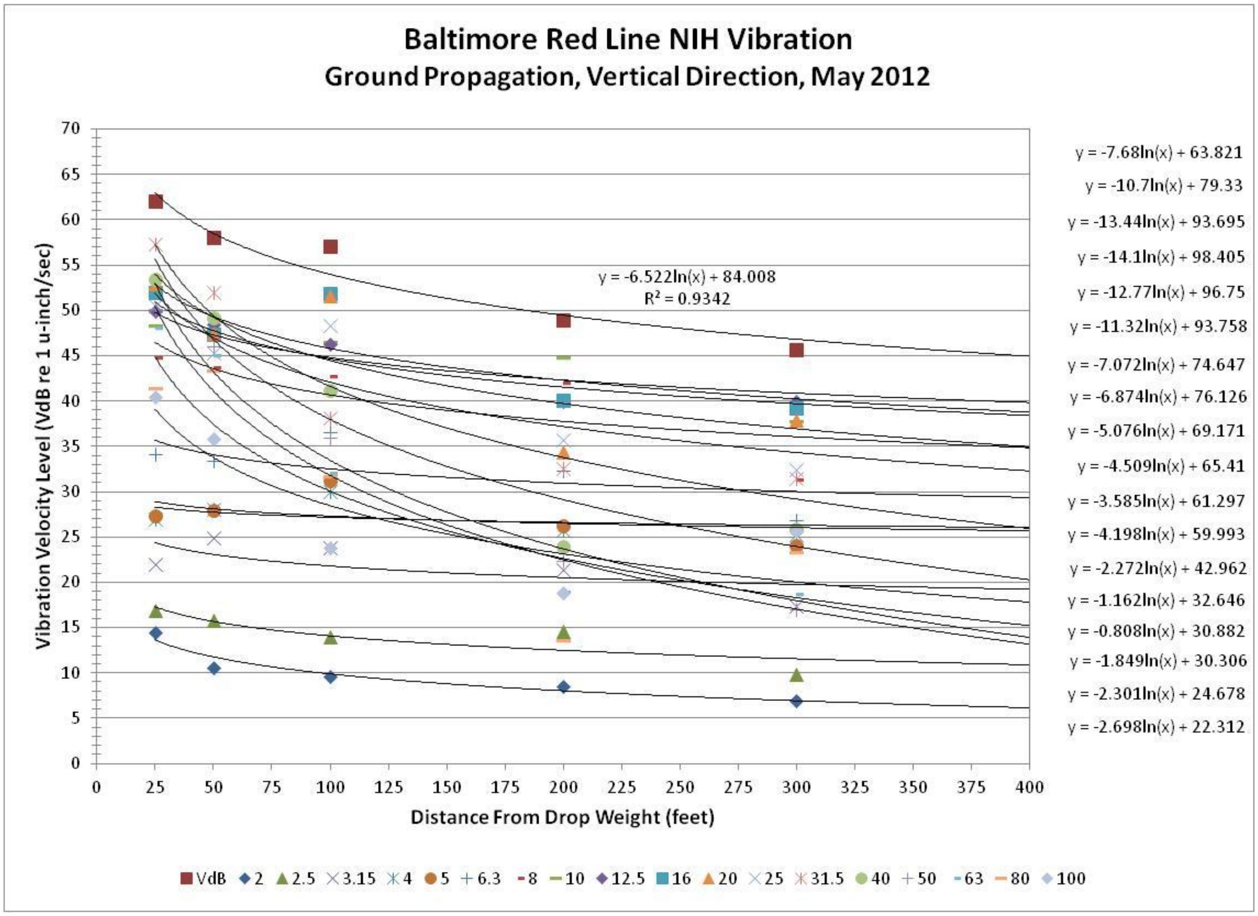


Figure 5: Third-Octave Band Ground Propagation Curve Fit Equations

The equations shown in **Figure 5** are natural log curve fits for each third-octave band. However, it is more common in the acoustics industry to express these types of equations in a Log (base 10) format, which can be done simply by multiplying the leading multiplier by 2.303 and keeping the constant the same. For example, the ground propagation loss equation for broadband VdB levels was converted to Log (base 10) by multiplying the -6.522 term by 2.303, and the result was then normalized to start at a reference distance of 25 feet by subtracting 63.0 (the absolute broadband VdB level at 25 ft) from the constant of 84.0. The new ground vibration attenuation equation can be expressed as **VdB = -15.02 Log (distance from source in feet) + 21.0.** The ground propagation attenuation equations for each individual third-octave band are developed in the same manner. The equations are provided in **Table 3**.

Table 3: Log (base 10) Ground Vibration Propagation Equations

GROUND PROPAGATION MODEL ADJUSTMENT			
NORMALIZED TO START AT 25 FEET			
X = DISTANCE FROM SOURCE IN FEET			
VdB =	-15.02	Log(X) +	21.00
2HzVdB =	-6.21	Log(X) +	8.69
2.5HzVdB =	-5.30	Log(X) +	7.41
3.15HzVdB =	-4.26	Log(X) +	5.95
4HzVdB =	-1.86	Log(X) +	2.60
5HzVdB =	-2.68	Log(X) +	3.74
6.3HzVdB =	-5.23	Log(X) +	7.31
8HzVdB =	-9.67	Log(X) +	13.52
10HzVdB =	-8.26	Log(X) +	11.54
12.5HzVdB =	-10.38	Log(X) +	14.52
16HzVdB =	-11.69	Log(X) +	16.34
20HzVdB =	-15.83	Log(X) +	22.13
25HzVdB =	-16.29	Log(X) +	22.77
31.5HzVdB =	-26.07	Log(X) +	36.44
40HzVdB =	-29.41	Log(X) +	41.11
50HzVdB =	-32.47	Log(X) +	45.39
63HzVdB =	-30.95	Log(X) +	43.27
80HzVdB =	-24.64	Log(X) +	34.45
100HzVdB =	-17.69	Log(X) +	24.73

7. Building Coupling Transmissibility

The next step in the analysis involved determining the transmissibility of vibration from outside to inside the NIH building itself. This is also called foundation coupling loss or attenuation. In this case the transmissibility measurements had to be performed at two different locations in the NIH building because of two very different structural conditions.

The EM and MRI devices were located in the sub-basement (2 floors below grade) at the building's northwest corner. The floor under the EM and MRI machines is a "floating floor", meaning it has intentionally been detached from the building's walls and foundation so that ambient vibration levels from outside the building are reduced considerably before reaching the EM or MRI devices. Using the drop-weight at a fixed point outside the building, vibration levels were measured proximate to the outside wall at grade (**Photo 7**), and inside the building's basement in Mechanical Room B1A327 (**Photo 8**) as directly as possible under the point where the exterior measurements had been conducted.

Similarly, separate vibration transmissibility measurements were performed at the building's southwest corner in order to evaluate the animal laboratory which is located in the sub-basement (3 floors below grade). In this case there was a 4-foot-wide earth-filled concrete retention wall buried underground. Therefore, the drop-weight was positioned outside of the retention wall in order to include its effects in the transmissibility results. Drop-weight vibration measurements were performed on the ground outside of the retention wall (**Photo 9**) and inside the basement on the floor in Storage Room B1C901 (**Photo 10**), as directly as possible under the point where the exterior measurements had been conducted.

In both cases, several drop-weight tests were performed in order to have sufficient data samples for statistical averaging purposes. The measurement instrumentation was carefully examined during the tests to ensure that there was sufficient vibration signal-to-noise ratio produced by the drop-weight to yield meaningful results.

When expressed as vibration velocity levels in decibels, the transmissibility results were computed by simply subtracting the interior vibration levels from the exterior vibration levels, as shown in **Figure 6**. As can be seen, the resulting effect on the broadband vibration level from outside to inside the building was minus 20 VdB for the Animal Lab area with the underground retention wall, and as much as minus 34 VdB for the EM and MRI area because of the extra attenuation attributable to the floating floor.

Photo 7: Outside EM and MRI Area

Photo 8: Inside Room B1A327 Near EM and MRI Area

Photo 9: Outside Animal Lab Area

Photo 10: Inside Room B1C901 Near Animal Lab Area

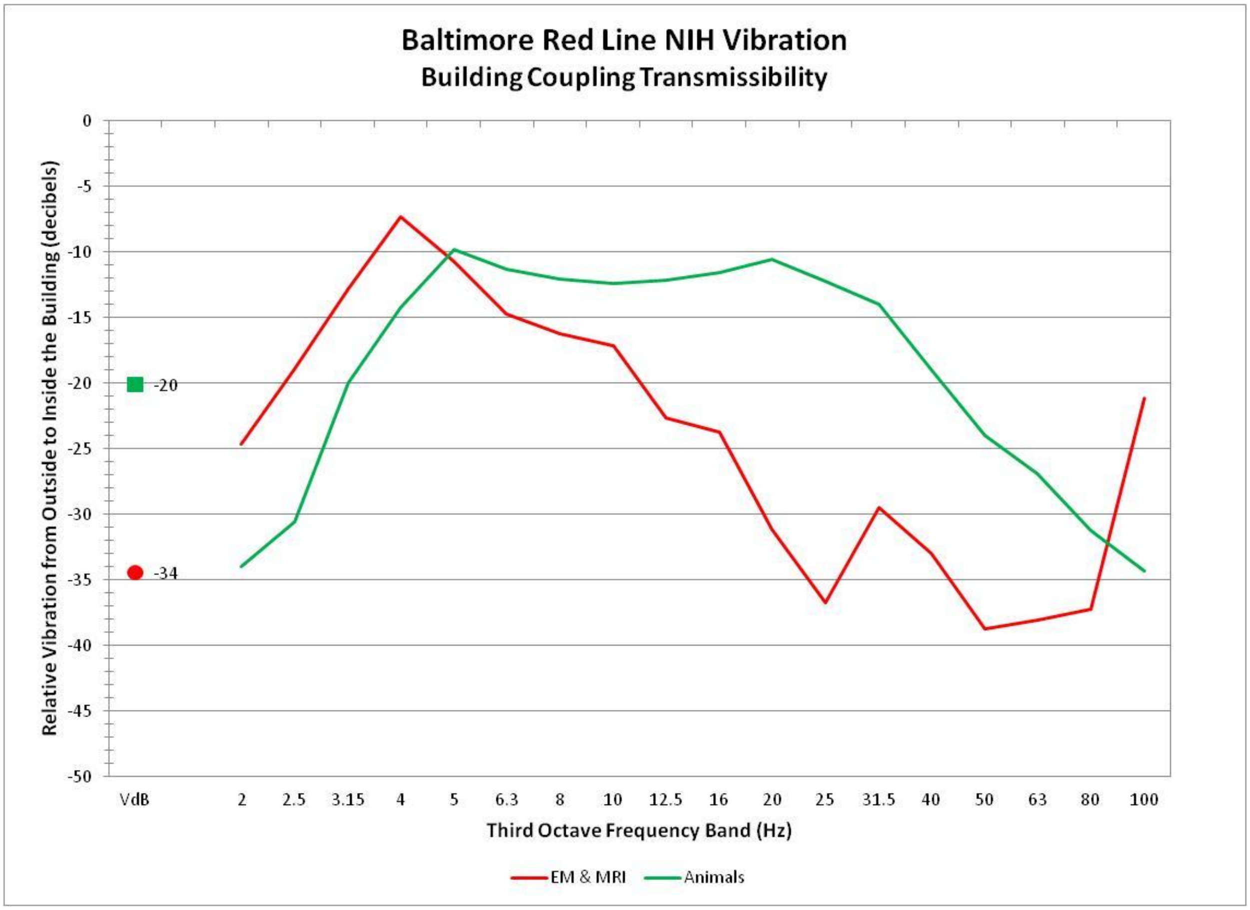


Figure 6: Building Coupling Transmissibility Results

8. Ambient Vibration Levels

A related step in this assignment involved measuring existing ambient vibration levels near the EM and MRI devices and in the animal laboratory area. While it is instructive to compare current ambient vibration levels to future predicted Red Line vibration levels, existing ambient vibration levels are not required for developing the Red Line vibration prediction model. It is noteworthy however, that the vibration sensitive devices and animal experiments inside the NIH building are currently being successfully operated and conducted when exposed to the existing ambient vibration levels documented through these measurements.

Ambient vibration level measurements were performed in close proximity to the vibration sensitive areas in the NIH building. Ambient data was collected for periods of about 15 to 30 minutes during the mid-day on May 8th, 2012. For the EM, ambient measurements were performed directly at the base of the microscope in Room B1A323. The electron microscope was labeled FEI Tecnia G Type: FP 5016/40. For the MRI, ambient vibration measurements were performed in the adjacent Control Room B1A737 which is on the same floor slab as the actual MRI machine. Two sets of ambient vibration data were collected for the MRI machine, one with the MRI running at “normal” speed and one with the MRI running at “high” speed. Finally, for the animal laboratory, ambient vibration data was collected in Store Room B1C909 which shared common walls and floor slab with rooms containing the animals.

The resulting ambient vibration levels are shown in **Figure 7** along with the FTA’s VC criteria curves. As can be seen, measured broadband ambient vibration levels of 45 VdB approach or exceed VC-E criteria for the MRI at high speed and for the Animal Lab area. Somewhat lower broadband ambient vibration levels of 39 VdB were found for the MRI at normal speed and for the EM area.

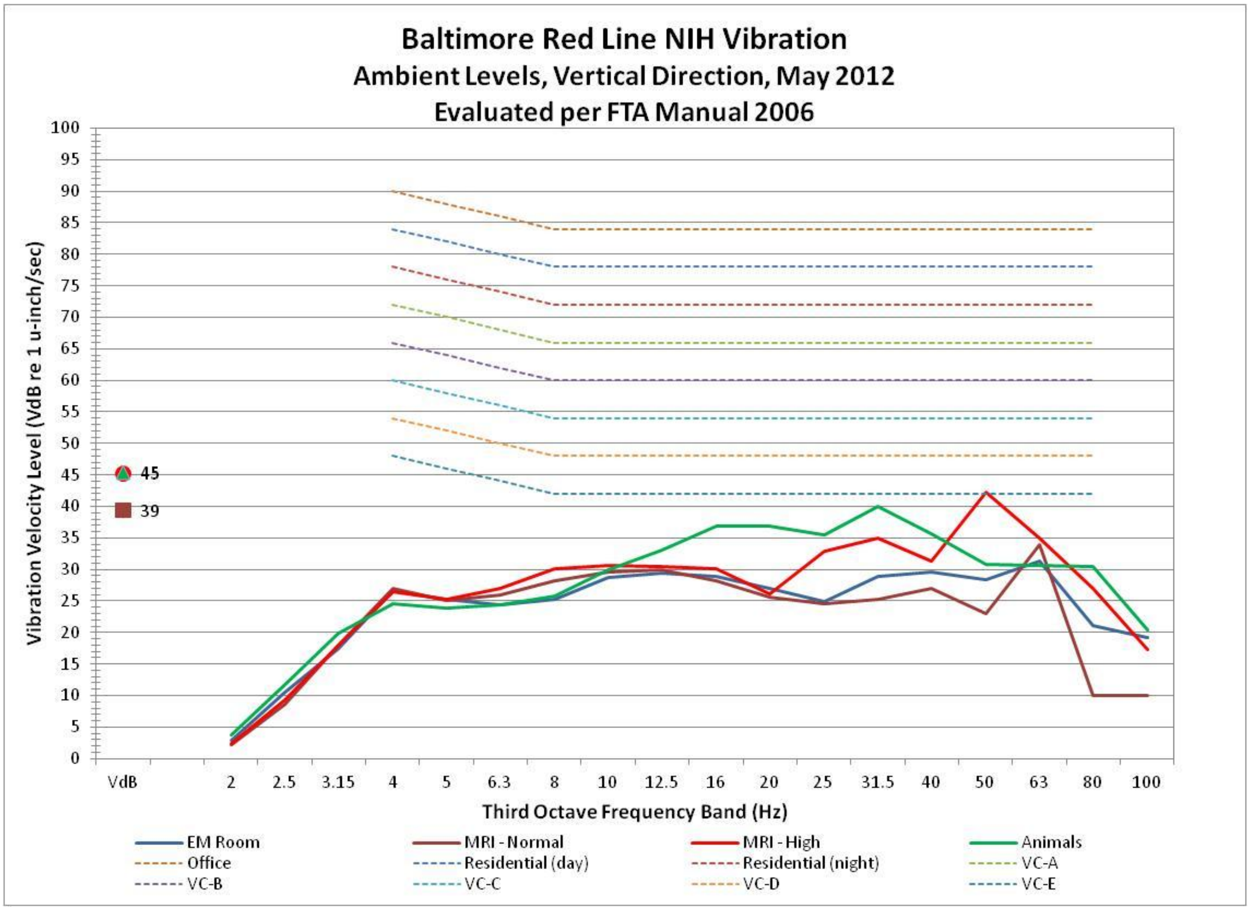


Figure 7: Ambient Vibration Levels

9. Results and Conclusions

The results of the various analysis steps described above were summed together to complete the vibration prediction model for this study. In general, conservative (i.e. worst-case) assumptions were made in order to predict the highest vibration levels that might be reasonably expected. The important variables used in the final vibration model included the following:

- Distance from proposed Red Line track location to NIH building's northeast corner = 470 feet
- Distance from proposed Red Line track location to NIH building's southwest corner = 310 feet
- Type of LRT vehicle assumed for proposed Red Line service = Bombardier FLEXITY Swift trains
- Type of track assumed for proposed Red Line service = ballast and tie track
- Speed assumed for proposed Red Line LRT vehicles = 30 miles per hour

Given these assumptions and input data, the results of the vibration prediction model can be seen in **Figure 8** for both the EM and MRI area, and the Animal Lab area. The future Red Line LRT-induced broadband vibration level for the EM and MRI area is predicted to be an extremely low 23 VdB, due largely to its floating floor. The future LRT-induced broadband vibration level affecting the Animal Lab area is expected to be a slightly higher, but still very low 33 VdB. The results indicate that none of these areas inside the NIH building are expected to be exposed to future Red Line vibration levels approaching or exceeding FTA's stringent VC criteria.

Moreover, the predicted Red Line LRT vibration levels are expected to remain well below the electron microscope manufacturer's recommended limit of 300 micro-inches/second (i.e. 50 VdB) as well as remaining several orders of magnitude below existing ambient vibration levels that currently have no adverse effect on these respective areas.

The predicted Red Line LRT vibration levels inside the NIH building, relevant criteria limits, ambient levels and conclusions regarding compliance are summarized in **Table 4**. *Consequently, it can be reasonably concluded that the Red Line LRT project poses no risk of adversely impacting the vibration sensitive areas inside the NIH building.*

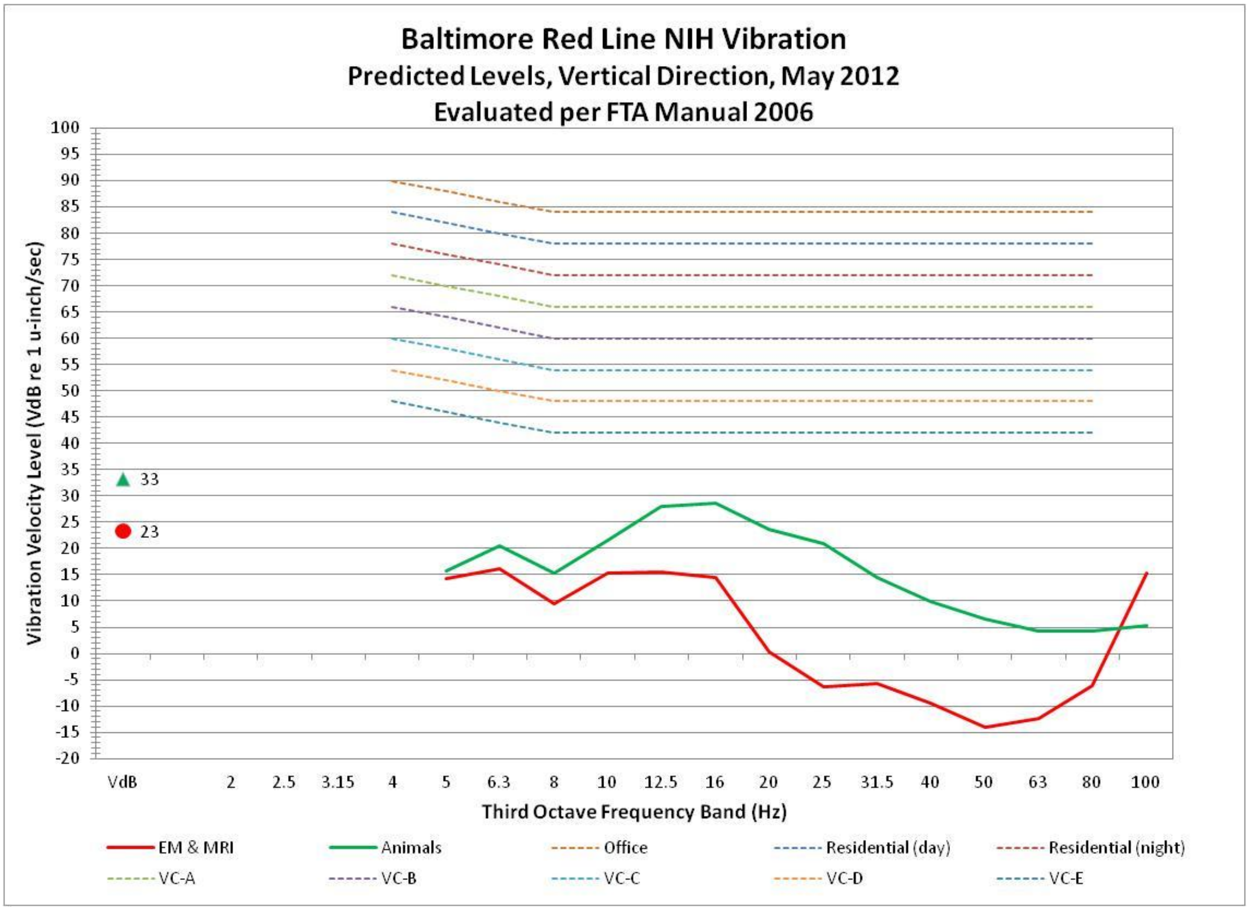


Figure 8: Predicted Red Line LT Vibration Results Inside NIH Building

Table 4: Summary of Red Line Vibration Results Inside NIH Building

Location Inside NIH Building	Predicted Red Line LRT Vibration Level (VdB re 1µ-inch/sec)	Ambient Vibration Level (VdB re 1µ-inch/sec)	FTA Manual VC Criteria (VdB re 1µ-inch/sec)	Manufacturer's Specification (VdB re 1µ-inch/sec)	Compliance or Exceedance
Electron Microscope (EM)	23 VdB	39 VdB	VC-D 48 VdB	50 VdB	Complies
Magnetic Resonance Imaging (MRI)	23 VdB	39 - 45 VdB	VC-C 54 VdB	N/A	Complies
Animal Lab Area	33 VdB	45 VdB	72 VdB	N/A	Complies

APPENDIX C
SUPPORT DOCUMENTATION

Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: ________ Date: 12/13

Site ID: M1 Address: Chadwick School

Land Use: ❑ Residential ❑ Commercial ❑ Institutional ❑ Mixed ❑ Other ________

Measurement Data SLM Model: ________ ID # _____ Serial # ________

Weather: Temp (°F) ________ Wind ________ Humidity ________ Cloud Cover ________

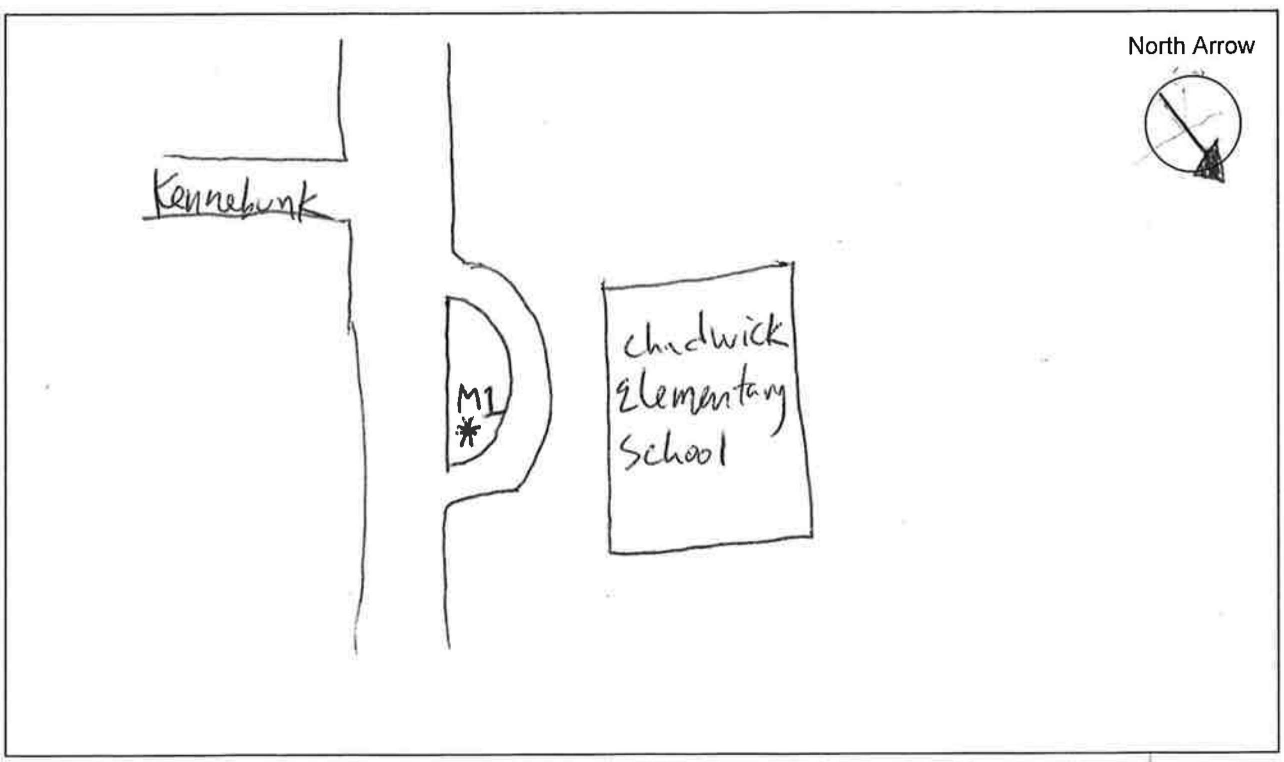
Proj 006

Time		Results				Calibration	
Start:	8:33	Leq05min:		Lmax:		Before:	
Stop:	8:53	Leq10min:		Lmin:		After:	
Total:	20min	Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Heavy traffic due to student drop-offs

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: MS/JJ Date: 12/12/11

Site ID: M2 Address:

Land Use: ☒ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ________

Measurement Data SLM Model: 2236 ID # 1 Serial # ________

Weather: Temp (°F) 42 Wind SW2 Humidity 49% Cloud Cover 4/9

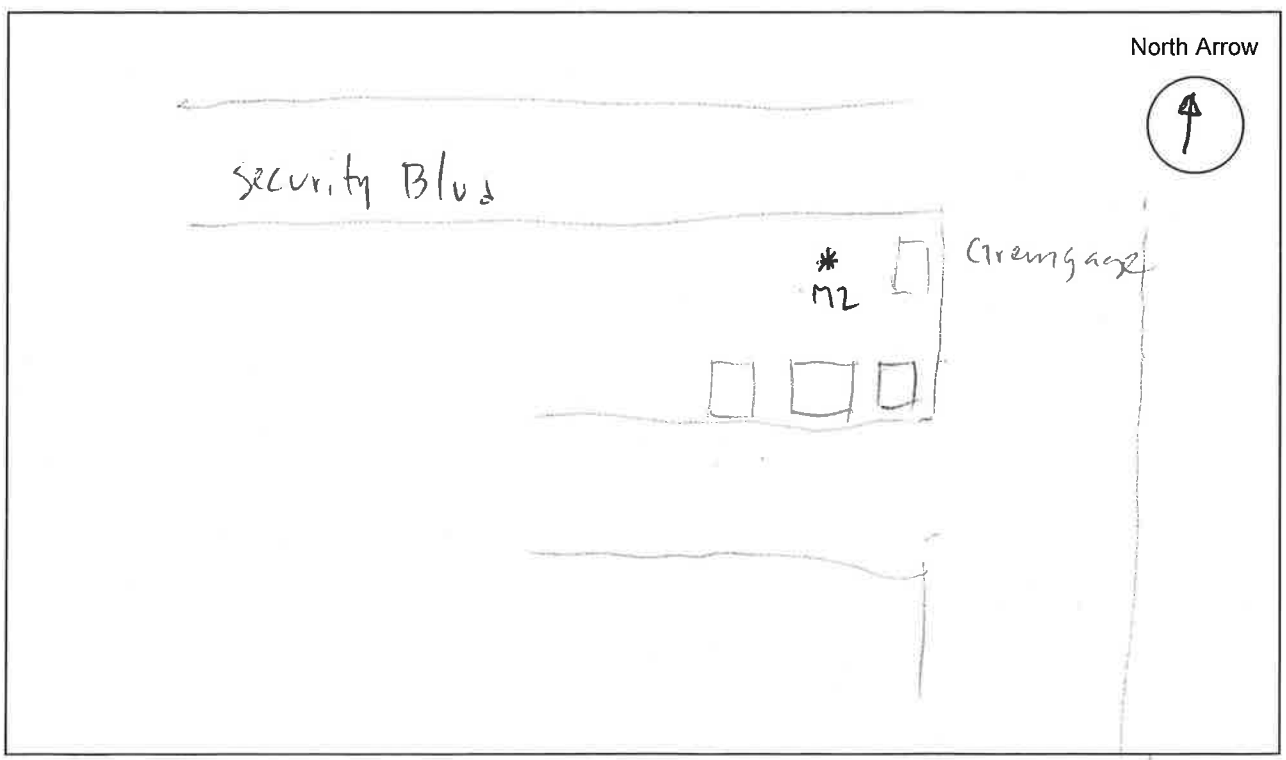
Time		Results				Calibration	
Start:	3:30	Leq05min:		Lmax:		Before:	
Stop:	3:30	Leq10min:		Lmin:		After:	
Total:	23:51	Leq15min:		L10:		Ref:	94.0 2.1
		Leq20min:		L90:		Model:	

Notes: Leq-55.1

Leaves ; Kids Playing

1952 Winder Rd.

Site Sketch:



Noise Monitoring Data Sheet

Project: Baltimore Red Line Project Operators: MS/SS Date: 12/12/11

Site ID: M3 Address: 2 Lenis Ct

Land Use: ☒ Residential ❑ Commercial ❑ Institutional ❑ Mixed ❑ Other ________

Measurement Data SLM Model: 2250 ID # _____ Serial # ________

Weather: Temp (°F) 42 Wind SW 2 Humidity ~~36%~~ 49% Cloud Cover 5%

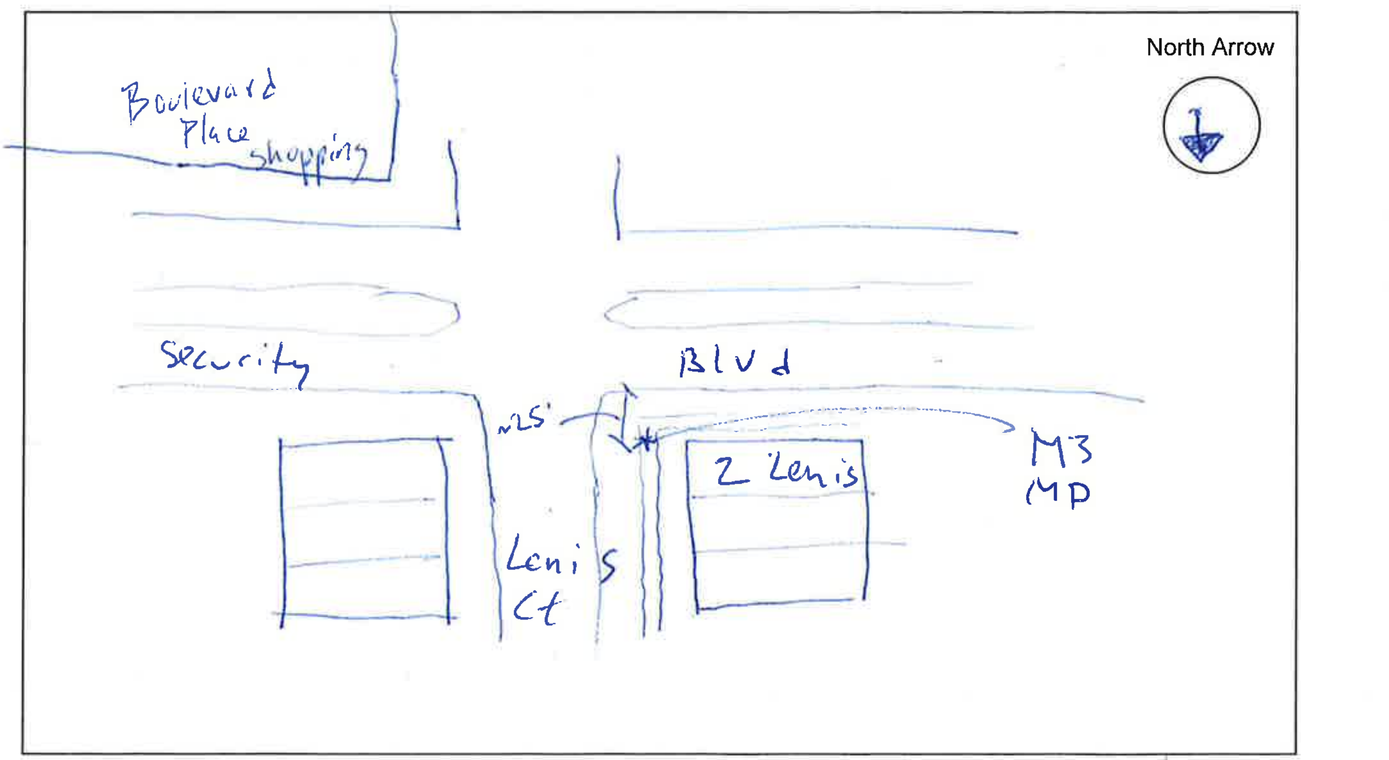
Time Proj 001		Results				Calibration	
Start:	2:33	Leq05min:		Lmax:		Before:	
Stop:	2:53	Leq10min:		Lmin:		After:	
Total:	20min	Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Light traffic, LOS A. Generally no other noise sources. No pedestrians, no aircraft fly overs. Occasional bird chirping. Mainly passenger car drive-bys. very little commercial traffic. No heavy trucks/buses. Traffic generally slow-moving. Approx 20-30 mph

Bus drive by @ 2:47:00

Site Sketch:



PM- 5:20 Start 12/12/11 proj 002

persistent hum near street light

Night- 12/14- 12:35AM

proj 015

Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: JS&MS Date: 2/8

Site ID: M3 Address: 2 Lenis Ct

Land Use: ☒ Residential ❑ Commercial ❑ Institutional ☒ Mixed ❑ Other ________

Measurement Data SLM Model: ________ ID # ________ Serial # ________

Weather: Temp (°F) 40F Wind 5MPH Humidity 60% Cloud Cover 60%

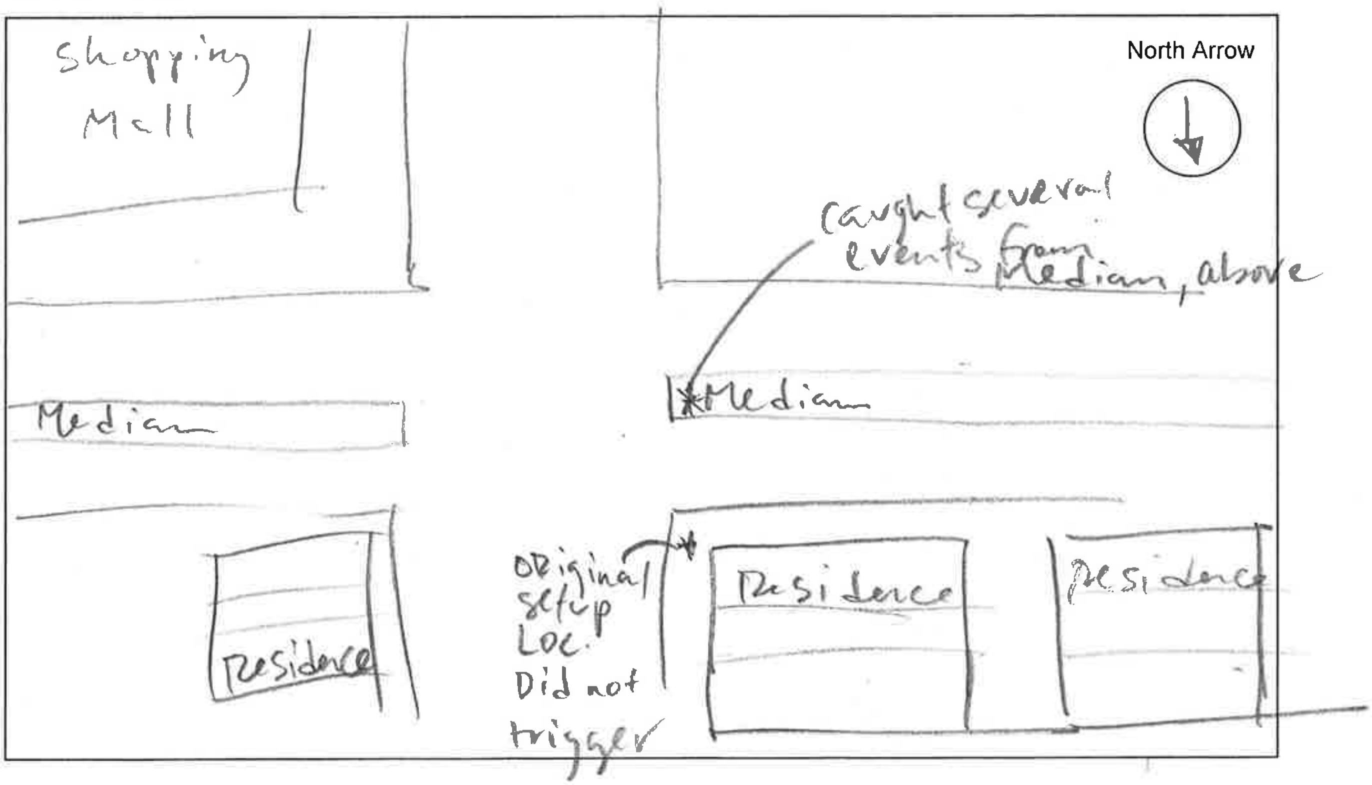
Time		Results				Calibration	
Start:		Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Vibration. 111654. Car PB - 30MPH .027
@10' - Hit sewer cap

112719 Bus PB - 30 MPH .027
@10'

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: JS/MS Date: 12/12/11

Site ID: M4 Address: Days Inn

Land Use: ❑ Residential ☒ Commercial ❑ Institutional ❑ Mixed ❑ Other ________

Measurement Data SLM Model: 2250 ID # _____ Serial # ________

Weather: Temp (°F) 41 Wind NE4 Humidity 67 Cloud Cover —

Proj 003

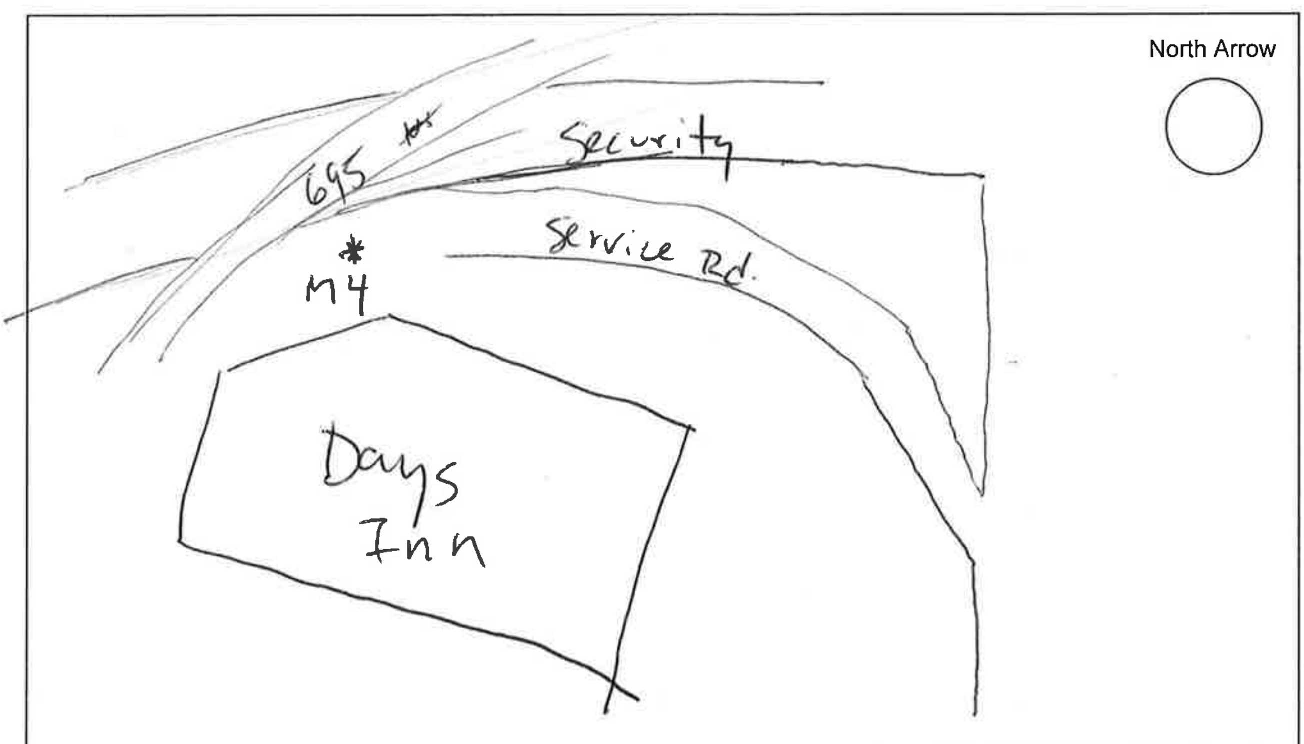
0

Time		Results				Calibration	
Start:	5:40	Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

No traffic on service Road
only 695 & Security Rd traffic

Site Sketch:



Proj 007 - 12/13 Midday

10:40 - 11:00

No traffic on Service Road.

Proj 016 - 1:04 AM 12/14 overnight

No traffic on service Rd

1:24 AM ~~St~~ finish time

Noise Monitoring Data Sheet

Project: Baltimore Red Line Project Operators: MS/JS Date: 12/12/11

Site ID: M5 Address: 6037 Baltimore

Land Use: ☒ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ________

Measurement Data SLM Model: LD ID # 812 Serial # ________

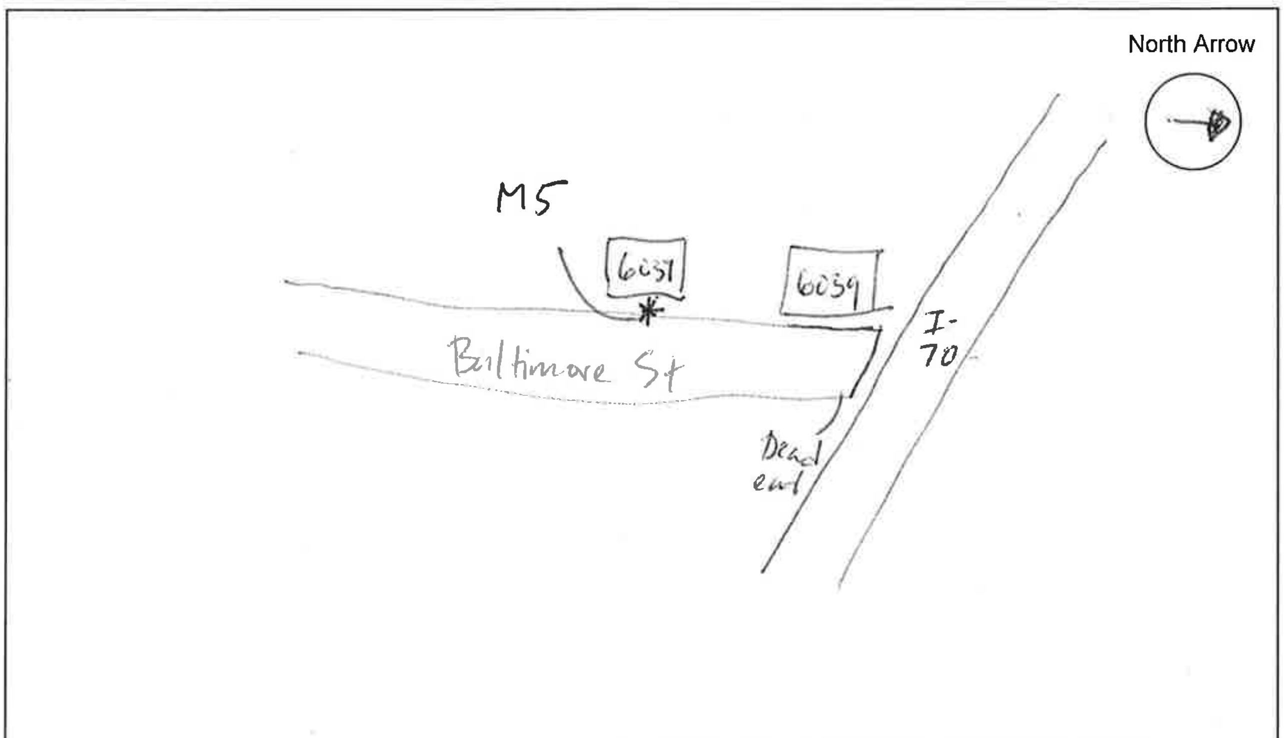
Weather: Temp (°F) 42 Wind SW2 Humidity 48% Cloud Cover n/a

Time		Results				Calibration	
Start:	4:20	Leq05min:		Lmax:		Before:	
Stop:	4:21	Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Quiet resitential street. Dead end, very little street traffic. Direct line of sight to I-70.

Site Sketch:



Noise Monitoring Data Sheet

Project: Baltimore Red Line Project Operators: JS&MS Date: 2/8/12

Site ID: M5 Address: 6037 Baltimore St

Land Use: ☒ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ______

Measurement Data SLM Model: ______ ID # ______ Serial # ______

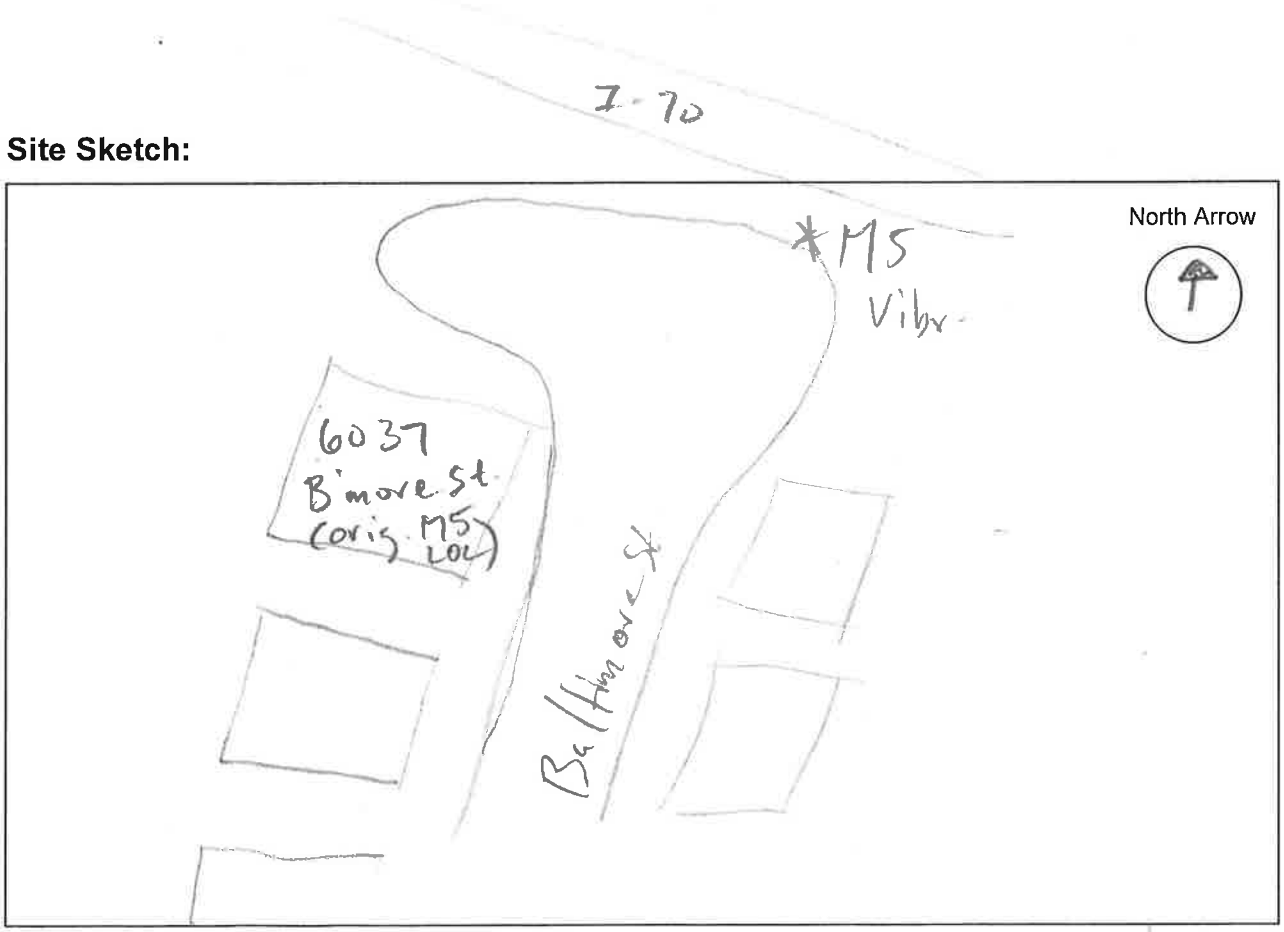
Weather: Temp (°F) 46 Wind 5 MPH Humidity 60% Cloud Cover 60%

Time		Results				Calibration	
Start:		Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

No data measured; too far from sources to register an event.

Site Sketch:



Noise Monitoring Data Sheet

Project: Baltimore Red Line Project Operators: MS/JS Date: 12/13

Site ID: M6 Address: ______

Land Use: ❑ Residential ❑ Commercial ❑ Institutional ❑ Mixed ❑ Other ______

Measurement Data SLM Model: ______ ID # ______ Serial # ______

Weather: Temp (°F) ______ Wind ______ Humidity ______ Cloud Cover ______

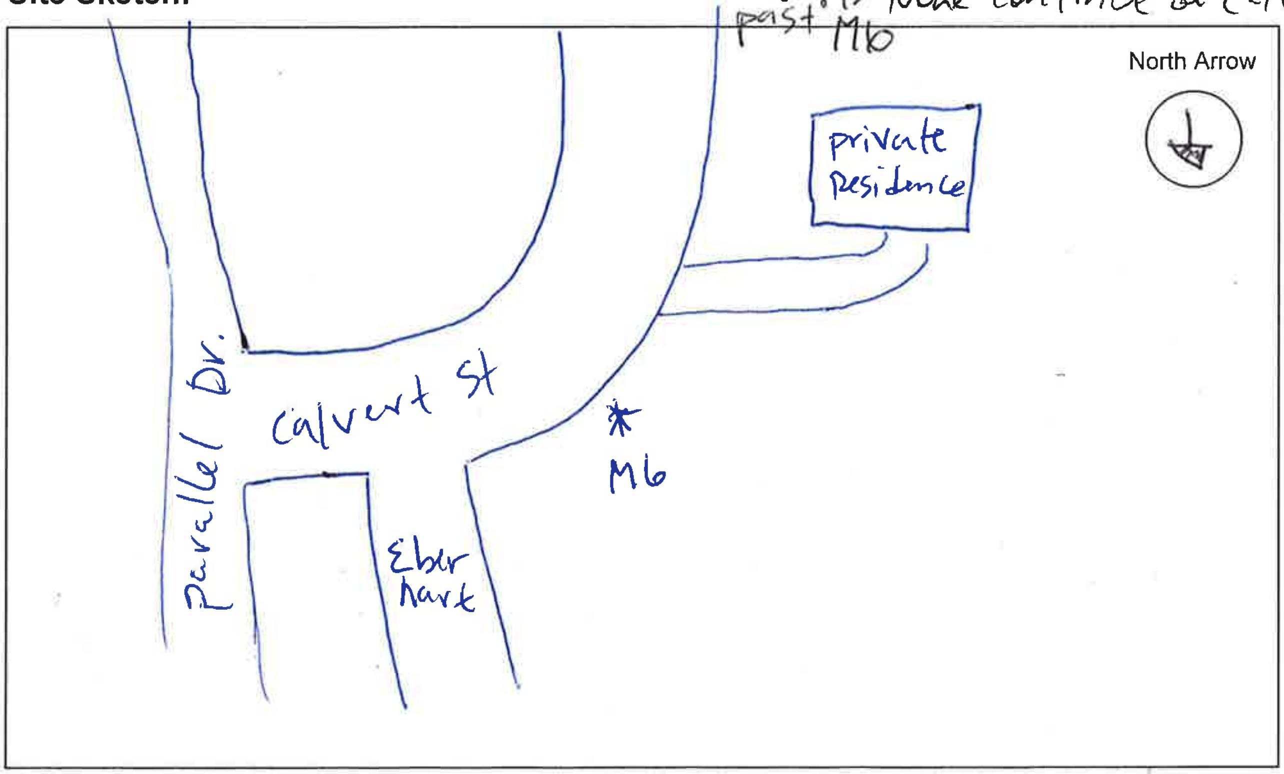
proj008

Time		Results				Calibration	
Start:	11:17	Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Proj 017 - 1:33 AM 12/14 Night time
Very quiet - no traffic
1:53 AM
Proj 023 - 5:40 PM peak - 5-10 cars/minute on parallel Drive. Some cars turn into Eberhart. None continue on Calvert past M6

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: MS/JS Date: 12/12

Site ID: ~~M5~~ M7 Address: 1542 Ingleside - Strawberry Hill Houses

Land Use: ☒ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ________

Measurement Data SLM Model: 2236 ID # 2 Serial # ________

Weather: Temp (°F) 42 Wind SW 2 Humidity 49% Cloud Cover n/a

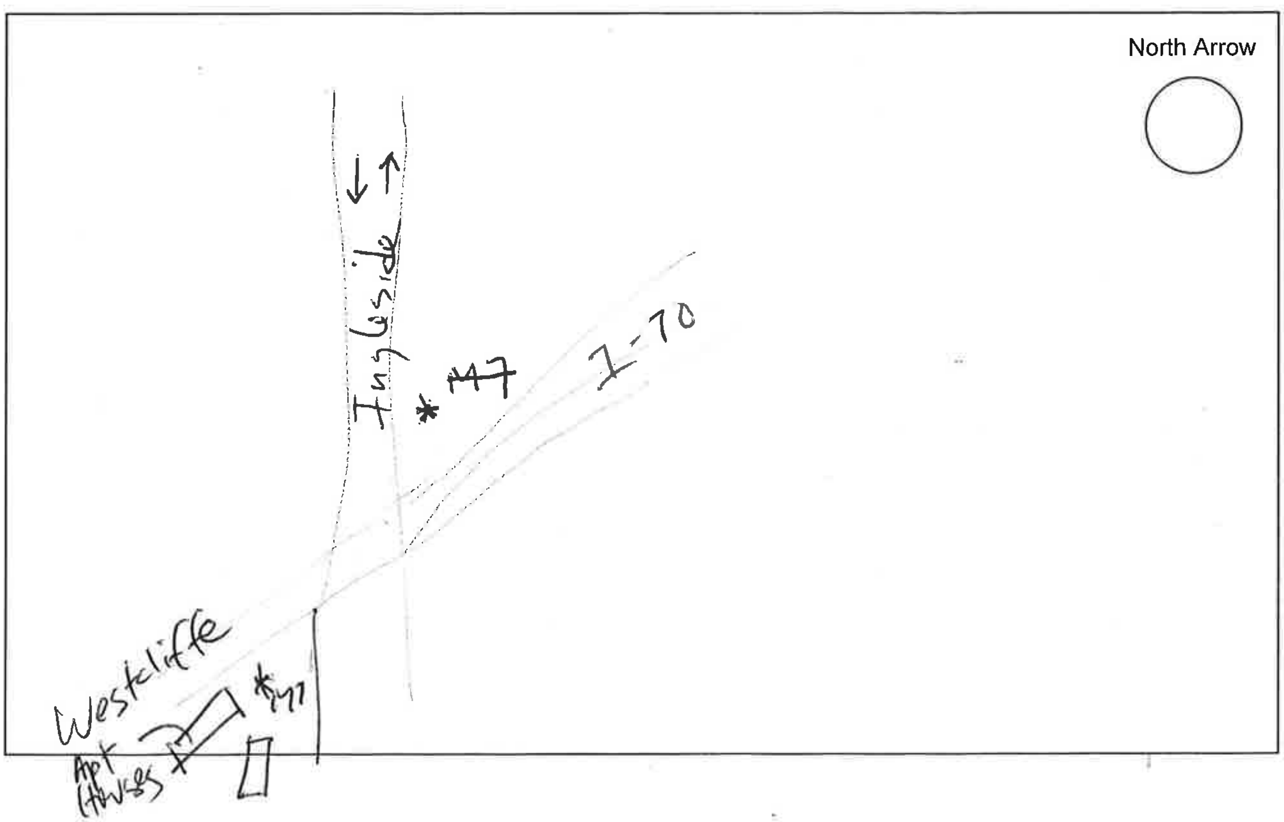
Time		Results				Calibration	
Start:	4:00	Leq05min:		Lmax:		Before:	114
Stop:	4:05	Leq10min:		Lmin:		After:	114
Total:	24:05	Leq15min:		L10:		Ref:	~~94.0~~ 114.
		Leq20min:		L90:		Model:	

Notes:

Leq. 66.9

Crunchy fall leaves underfoot
Frequent car passby on Ingleside

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: MS/JS Date: 12/13/11

Site ID: M8 Address: 1217 ~~Kirkwood~~ Stamford - Backyard

Land Use: ☒ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ________

Measurement Data SLM Model: 2236 ID # 1 Serial # ________

Weather: Temp (°F) ________ Wind ________ Humidity ________ Cloud Cover ________

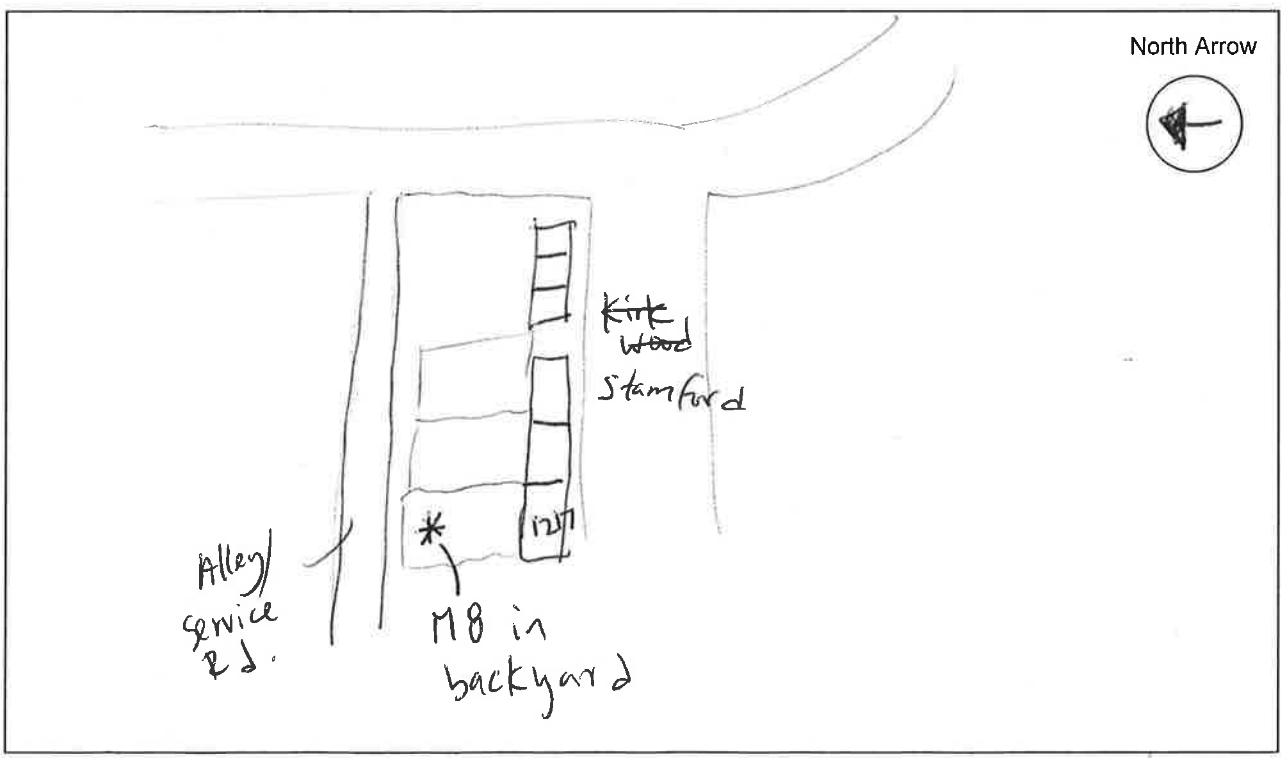
Time		Results				Calibration	
Start:	3:57pm	Leq05min:		Lmax:		Before:	
Stop:	4:58	Leq10min:		Lmin:		After:	
Total:	24hr 49m	Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Qveit backyard - fenced in. Very little if any traffic.

51.7 Leq

Site Sketch:



Noise Monitoring Data Sheet

Project: _Baltimore Red Line Project_ Operators: JS&MS Date: 2/8/12

Site ID: M8 Address: 1217 Stamford

Land Use: ☒ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ________

Measurement Data SLM Model: ________ ID # ______ Serial # ________

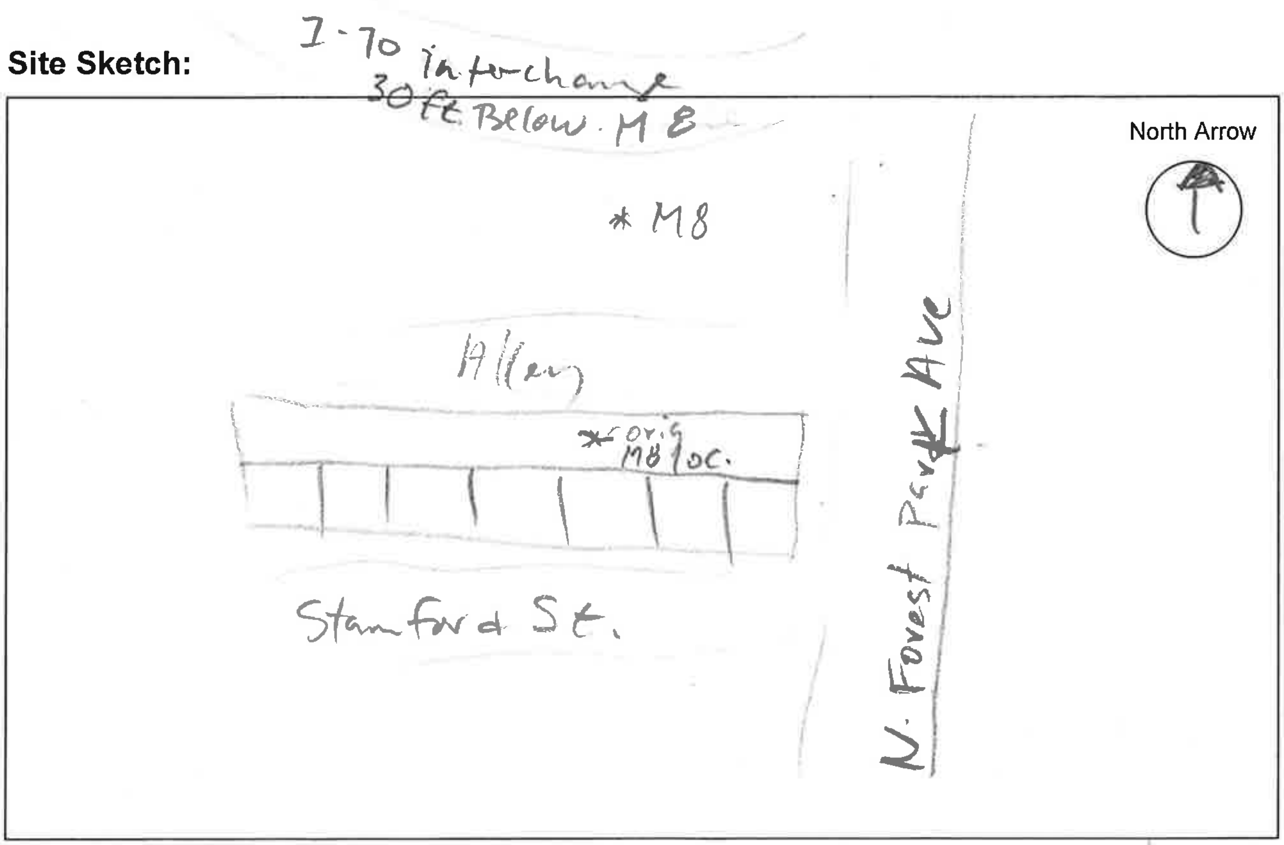
Weather: Temp (°F) 40 Wind 8 MPH Humidity 60% Cloud Cover 80%

Time		Results				Calibration	
Start:		Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Lëq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Vibration - Ambient - .024 115819
Car passby on cloverleaf did not trigger sensor

Site Sketch:



Noise Monitoring Data Sheet

Project: Baltimore Red Line Project Operators: MS/SS Date: 12/13

Site ID: M09 Address: Cooks Ln / St. Gemma

Land Use: ☒ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ________

Measurement Data SLM Model: 2250 ID # ____ Serial # ________

Weather: Temp (°F) 45 Wind NW 9 Humidity 34% Cloud Cover N/a

Proj 009

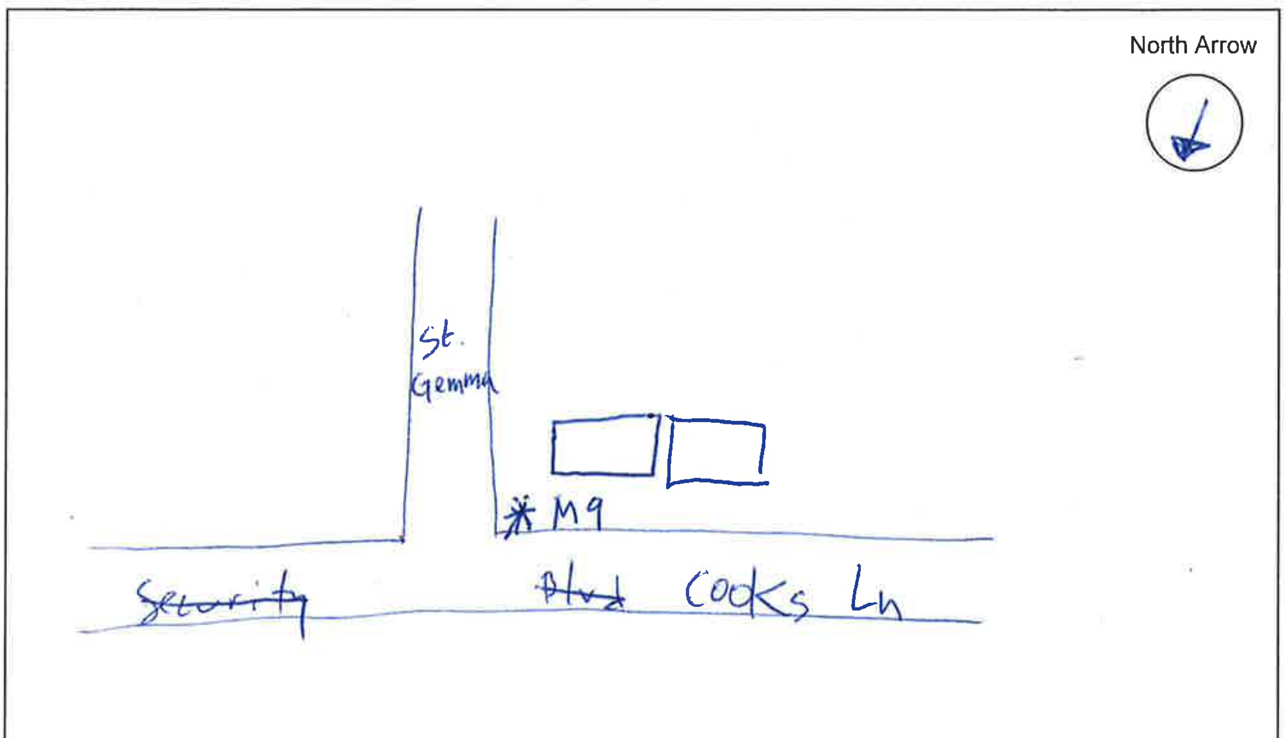
Time		Results				Calibration	
Start:	11:45	Leq05min:		Lmax:		Before:	
Stop:	12:05	Leq10min:		Lmin:		After:	
Total:	20min	Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:
Light traffic; no congestion. LOS A/B

Proj 012. 12/13 PM meas. - 4:53 start. - Heavier traffic LOS B/C
5:13 finish occasional police siren
Very little other noise

Proj 018 - 2:00AM 12/14 Nighttime. Quiet. Little traffic

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: JS&MS Date: 2/8

Site ID: M9 Address: Cooks Ln / St Gemma

Land Use: ☒ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ________

Measurement Data SLM Model: ________ ID # ______ Serial # ________

Weather: Temp (°F) 40 Wind 8 Humidity 60% Cloud Cover 85%

Time		Results				Calibration	
Start:		Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
Ambient - .021		Leq20min:		L90:		Model:	

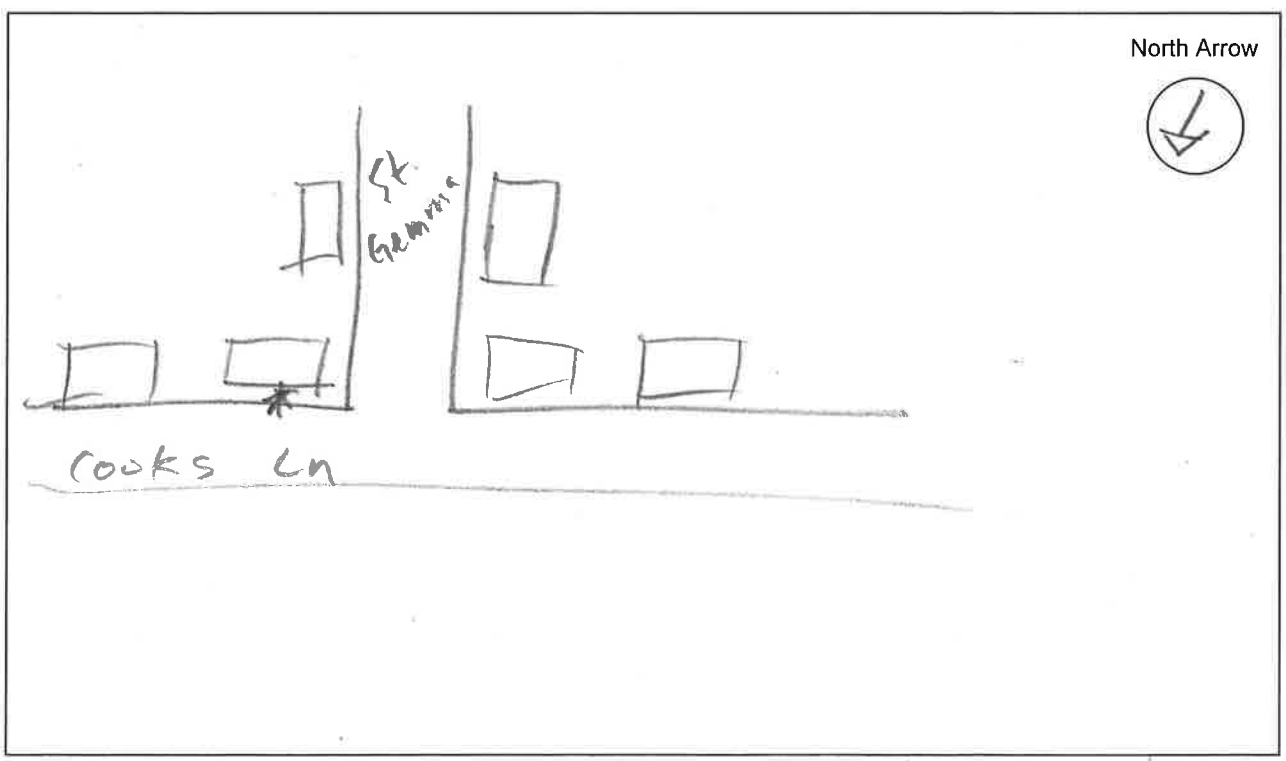
Notes:

Vibration 123907 - Bus drive by @ 15', 30 MPH .034 Bumpy Rd.

Mini school bus, 20 MPH, 15' <.023

LT truck - 124310 - .033, 25 MPH @ 10'

Site Sketch:



Noise Monitoring Data Sheet

Project: Baltimore Red Line Project Operators: JS/MS Date: 12/13

Site ID: M10 Address:

Land Use: ❑ Residential ❑ Commercial ❑ Institutional ❑ Mixed ❑ Other

Measurement Data SLM Model: ID # Serial #

Weather: Temp (°F) Wind Humidity Cloud Cover

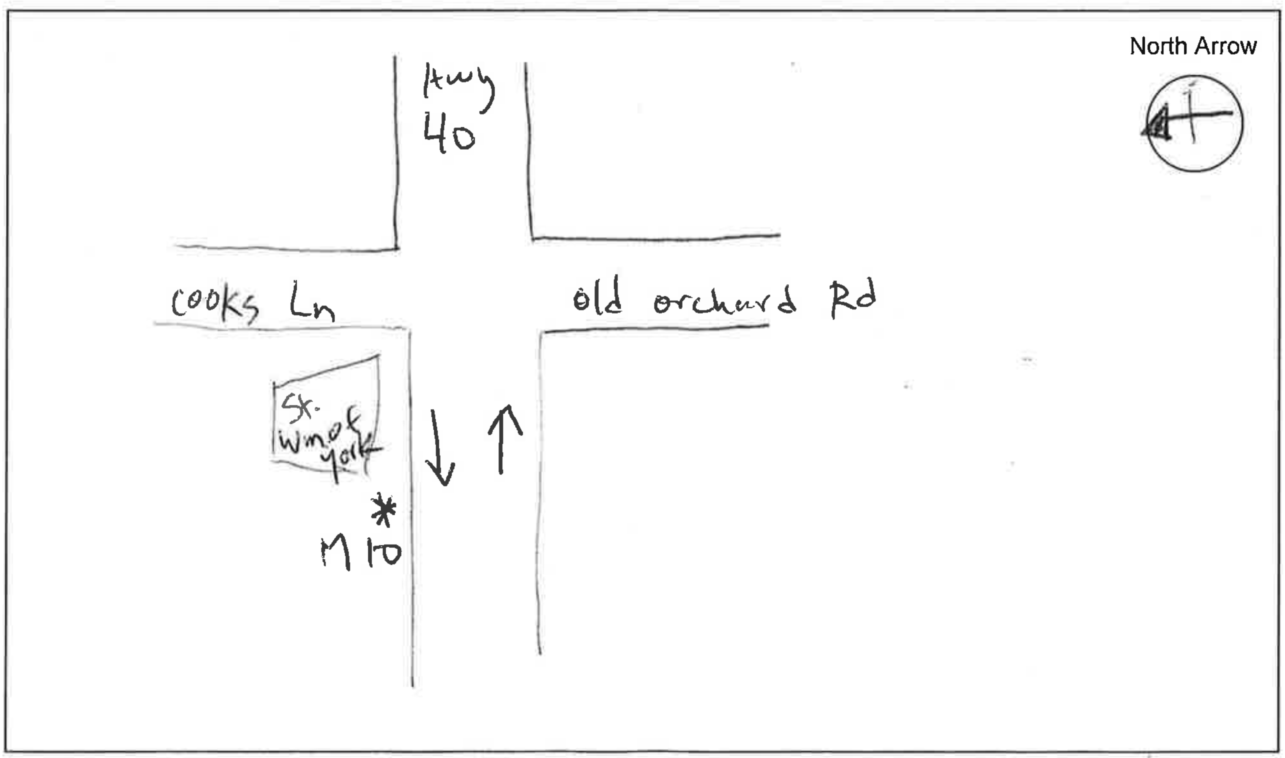
proj 005

Time		Results				Calibration	
Start:	7:55	Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Heavy traffic on 40. 4 travel lanes per direction.

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: MS/JS Date: 12/13/11

Site ID: M11 Address: Edmondson Ave / Cooks Ln

Land Use: ☒ Residential ❑ Commercial ❑ Institutional ❑ Mixed ❑ Other ______

Measurement Data SLM Model: ______ ID # ____ Serial # ______

MD

Weather: Temp (°F) ______ Wind ______ Humidity ______ Cloud Cover ______

Proj 010

Time		Results				Calibration	
Start:	1215	Leq05min:		Lmax:		Before:	
Stop:	1235	Leq10min:		Lmin:		After:	
Total:	20min	Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

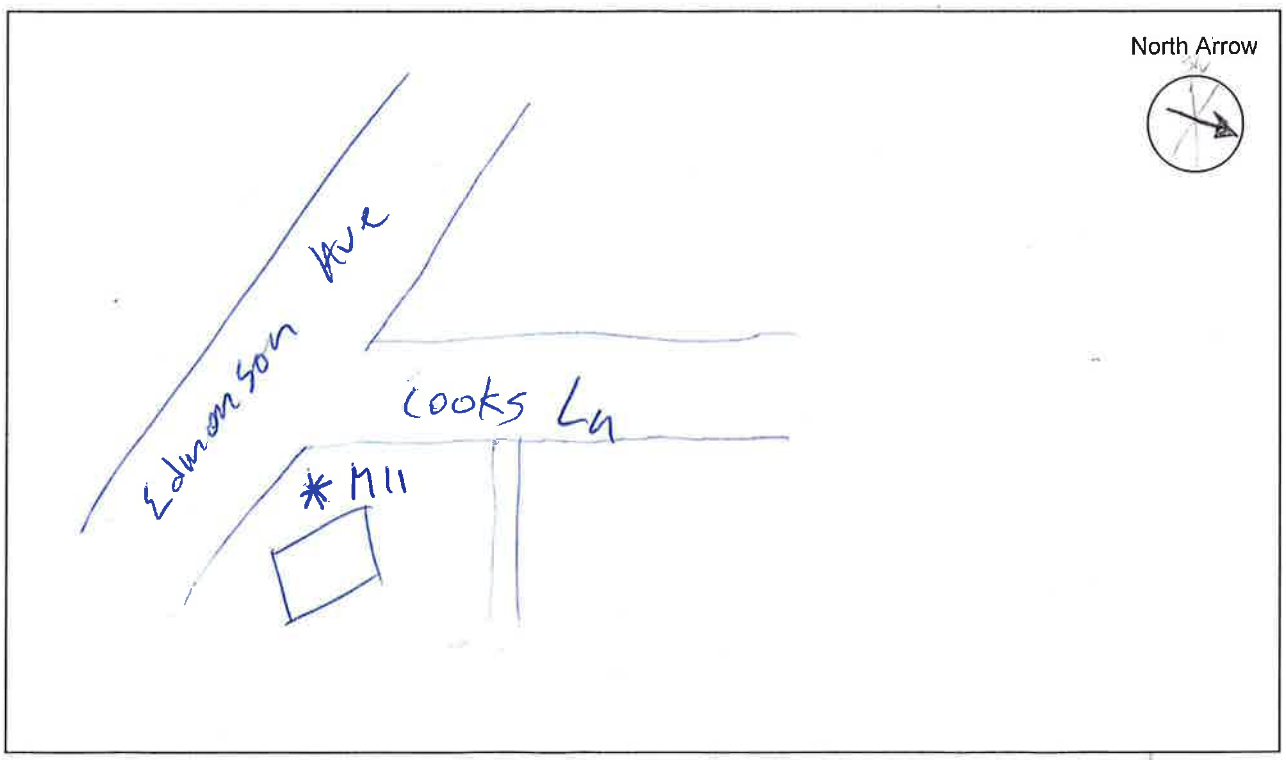
Notes:

Some traffic congestion. LOS B/C

PM - Proj 013 - 12/13 - Heavy traffic
5:25-5:45

Night Proj 019 - 12/14 2:25AM Very little traffic
2:27-2 Heavy truck passby

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: MS/JS Date: 12/13/11

Site ID: M12 Address: Edmundson Ave Episcopalian Church

Land Use: ❑ Residential ❑ Commercial ☑ Institutional ❑ Mixed ❑ Other ________

Measurement Data SLM Model: 2236 ID # 2 Serial # ________

Weather: Temp (°F) 50° Wind NW 5 Humidity 35% Cloud Cover n/a

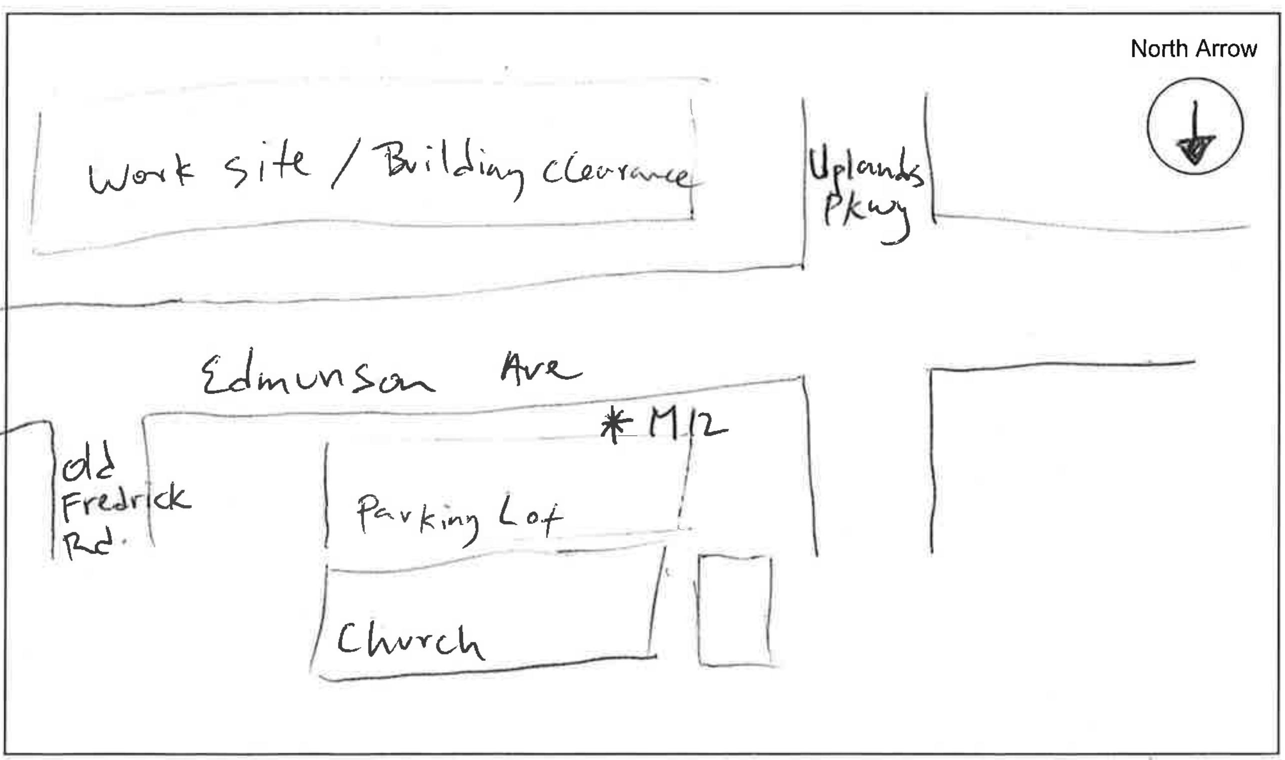
Time		Results				Calibration	
Start:	4:35	Leq05min:		Lmax:		Before:	
Stop:	6:30	Leq10min:		Lmin:		After:	
Total:	25:55	Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Heavy traffic on Edmunson.

69.8 Leq

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: MS/JS Date: 12/13

Site ID: M13 Address: Vaughn C Greene

Land Use: ☐ Residential ☐ Commercial ☐ Institutional ☒ Mixed ☐ Other ________

Measurement Data SLM Model: 2250 ID # _____ Serial # ________

Weather: Temp (°F) ________ Wind ________ Humidity ______ Cloud Cover ________

Proj' 011

Time MD		Results				Calibration	
Start:	12:45	Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Moderate amounts of traffic on Edmonson. Some heavy truck traffic

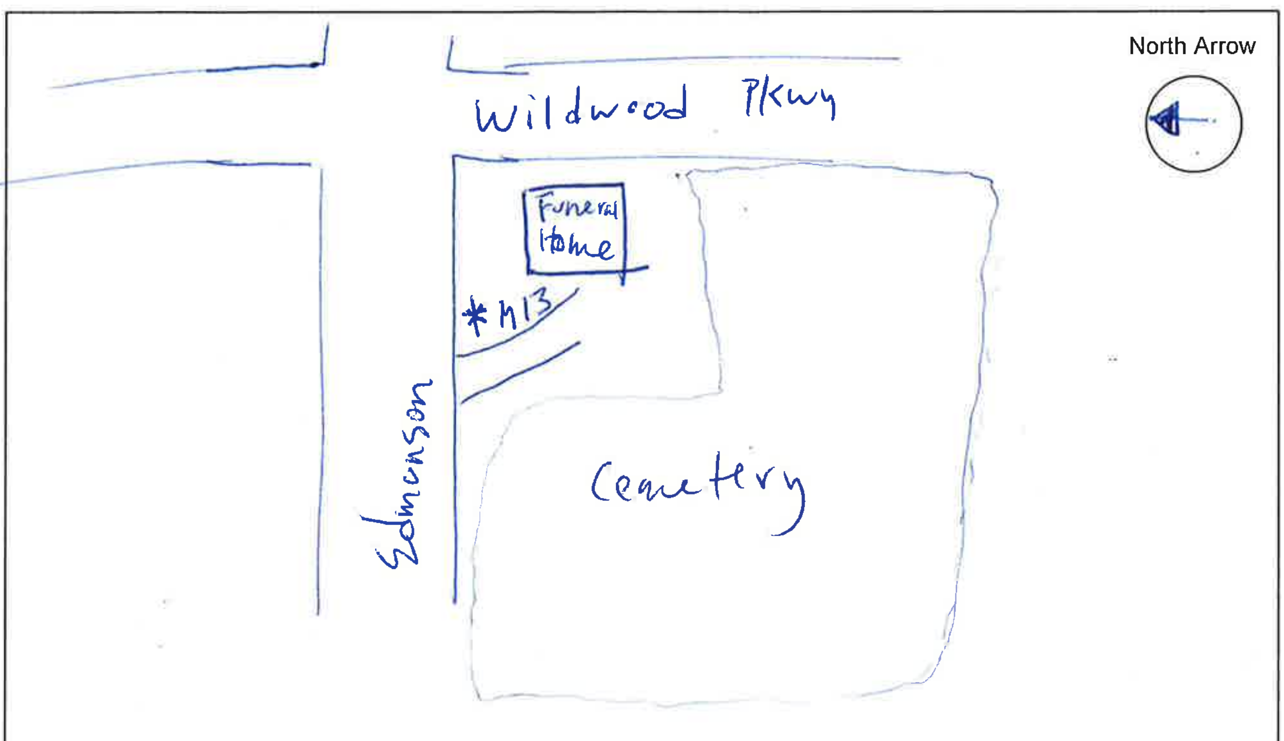
proj 14 - 5:52 PM 12/13 PM count

6:00 - police siren drive-by

proj 20 - 2:42 AM 12/14 - Night

2:49 - MTA bus drive by westbound lane

Site Sketch:



Proj 021- 12/14 5:25 PM count -5:35 · 10:00 min
022-
5:35-5:45- 10 min

Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: JS&MS Date: 2/9

Site ID: M13 Address: ______

Land Use: ☐ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ______

Measurement Data SLM Model: ______ ID # ______ Serial # ______

Weather: Temp (°F) 41 Wind 12 MPH Humidity 43% Cloud Cover 10%

Time		Results				Calibration	
Start:		Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Vibration

Multiple car driveby @ 10' did not trigger

school buse 15' did not trigger

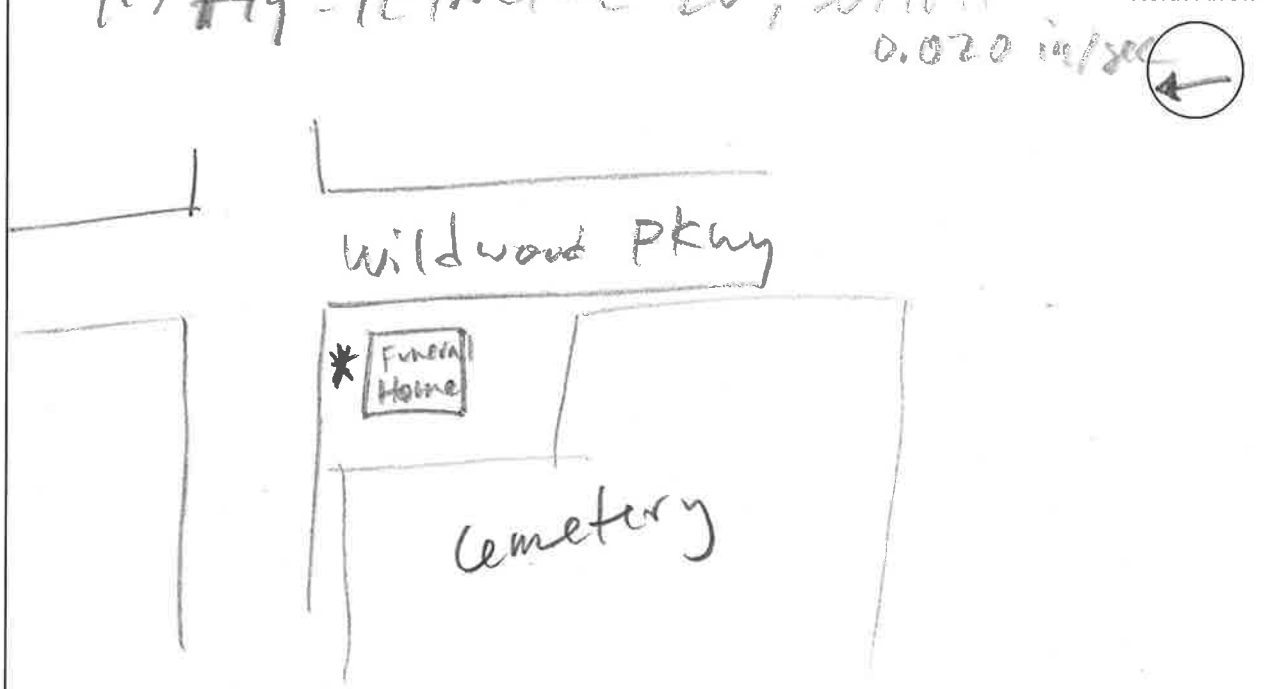
city buse 10' did not trigger

115311 - City busidle @ 10' .023 in/sec

115326 city bus accelerate @ 15' - 0.020

115749 - lt truck @ 20', 30 MPH 0.020 in/sec

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: MS/JS Date: 12/14

Site ID: M14 Address: W. Franklin St

Land Use: ☒ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ________

Measurement Data SLM Model: 2236 ID # 1 Serial # ________

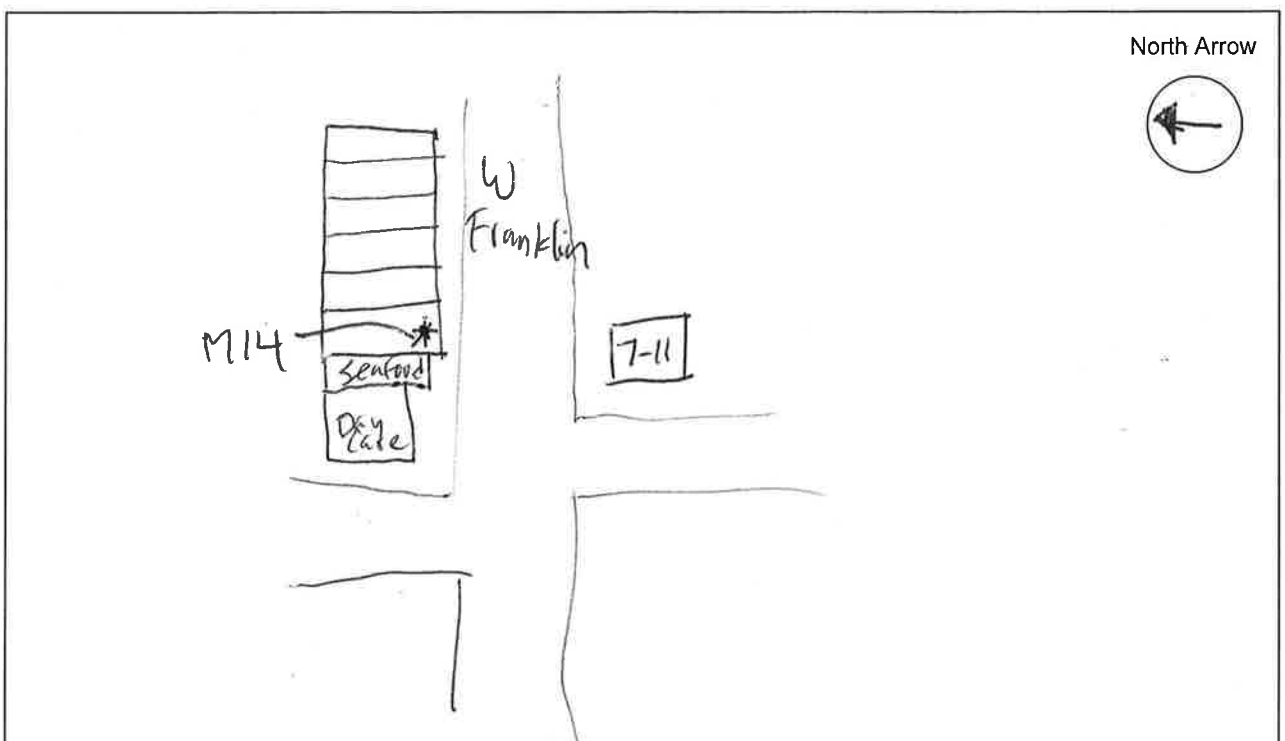
Weather: Temp (°F) ________ Wind ________ Humidity ________ Cloud Cover ________

Time		Results				Calibration	
Start:	5:00	Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Heavy traffic on W. Franklin. Signalized intersection

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: JS&MS Date: 2/6/12

Site ID: M14 Address: 2716 W. Franklin

Land Use: ☒ Residential ❑ Commercial ❑ Institutional ❑ Mixed ❑ Other ______

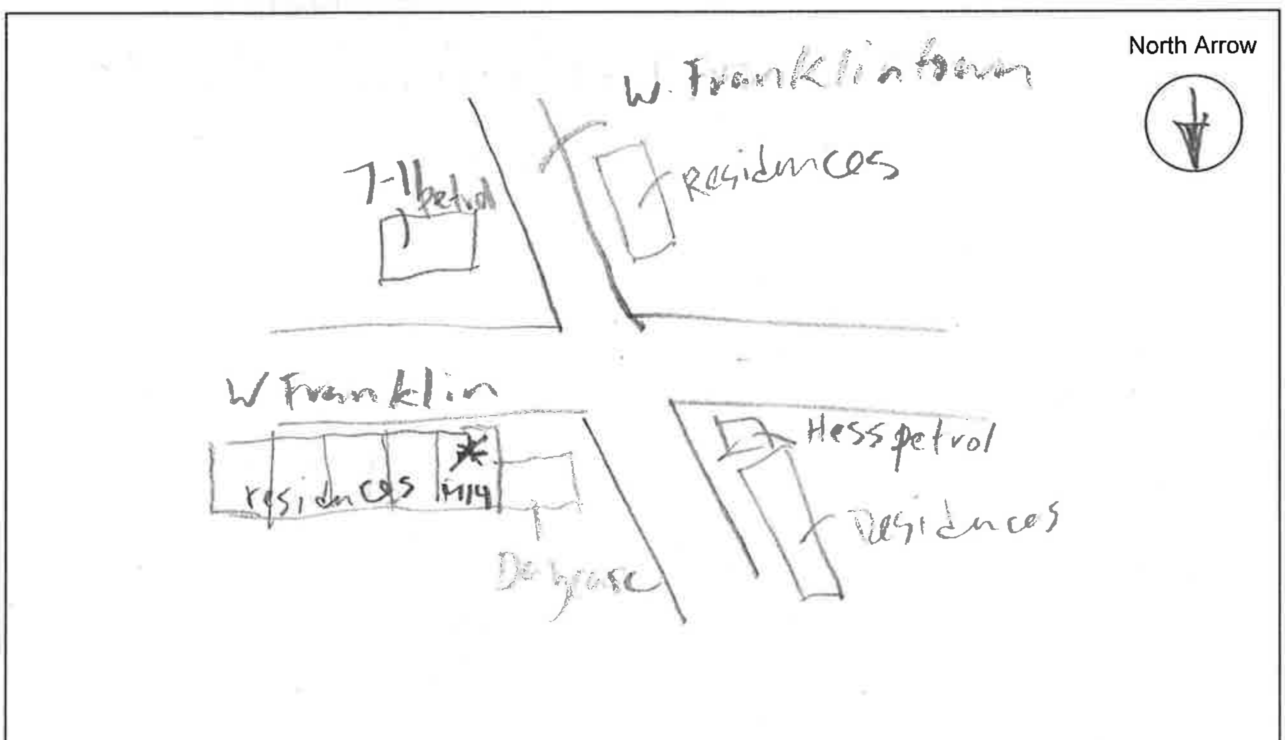
Measurement Data SLM Model: 2236 ID # 2 Serial # ______

Weather: Temp (°F) 50 Wind 5 Humidity 40% Cloud Cover 0

Time		Results				Calibration	
Start:	14:50	Leq05min:		Lmax:		Before:	
Stop:	14:45	Leq10min:		Lmin:		After:	
Total:	23:53	Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes: Ambient - 63
Passby - 73 dB
Leq - 69.8
Residential home of M/M C Evans
Heavy car traffic at signalized intersection

Site Sketch:



See Reverse

Noise Monitoring Data Sheet

Project: _Baltimore Red Line Project_ Operators: JS&MS Date: 2/6/12

Site ID: M15 Address: Smallwood / Mulberry

Land Use: ☐ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☒ Other Trans / Park

Measurement Data SLM Model: 225D ID # ____ Serial # ____

Weather: Temp (°F) ____ Wind ____ Humidity ____ Cloud Cover ____

Time		Results				Calibration	
Start:	1554	Leq05min:		Lmax:	62.6	Before:	
Stop:		Leq10min:		Lmin:	58.3	After:	
Total:		Leq15min:		L10:	62.1	Ref:	94.0
		Leq20min:	60.0	L90:	58.6	Model:	

Notes:

Proj 001

Stop controlled @ Smallwood
Hwy 40 traffic moving only @ 40 MPH approx

Site Sketch:

North Arrow

Lite traffic on Hwy 40 inbound

1557 - Police copter overhead
1558 Ambulance siren
160238 - Hwy truck PB, increased traffic
53.5 Ambient

Proj 004 - 2/7 - ~~B48~~ 13:38 start
52.7 Ambient w/o traffic
134040 - diesel bus PB @ 40MPH - 20'
134320 - Semi PB accelerating
134935 elec Bus PB @ 20' @ 30 MPH

See Reverse

Proj 010- 12:00:00 AM 2/8/12

~~Light tr~~

Little to no traffic on Mulberry.

Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: JS&MS Date: 2/7/12

Site ID: M16 Address: Mulberry @ Gilmore

Land Use: ☒ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ________

Measurement Data SLM Model: 2250 ID # ______ Serial # ________

Weather: Temp (°F) 50 Wind 6 MPH Humidity 50% Cloud Cover 20%

Time		Results				Calibration	
Start:		Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

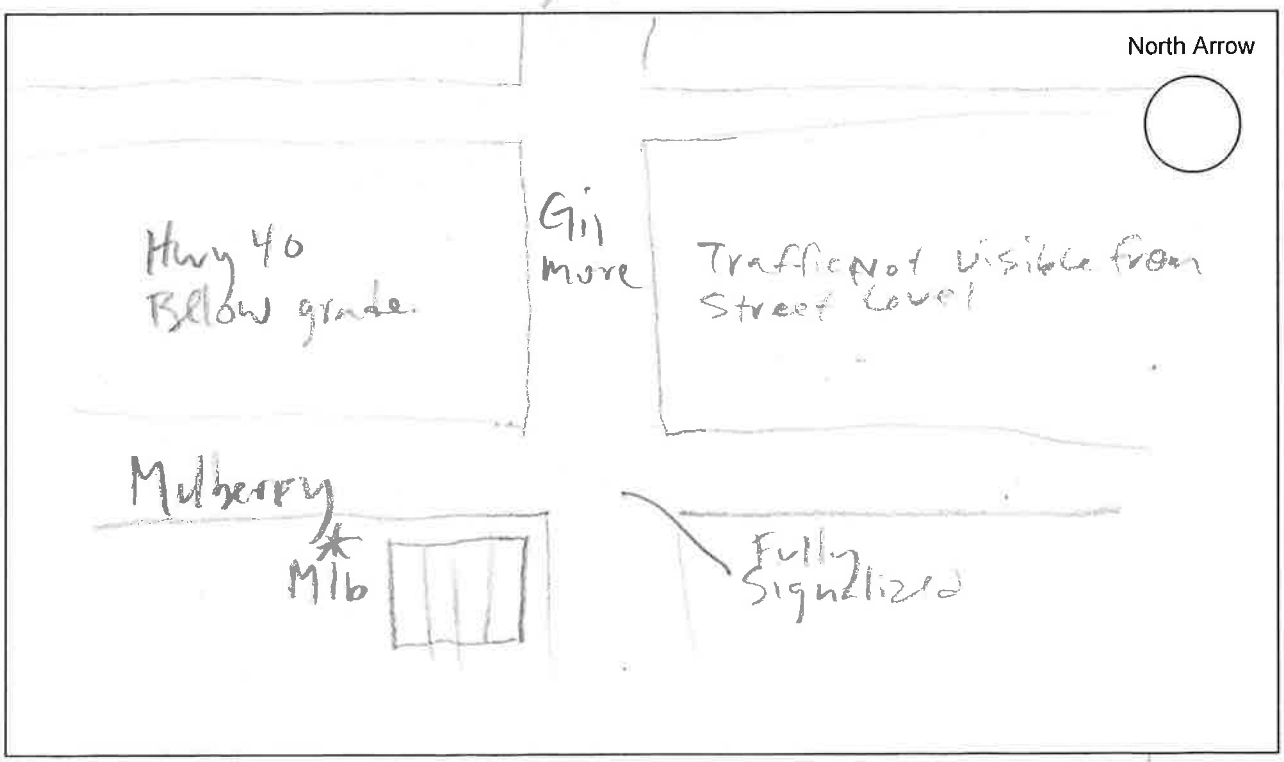
Notes:

Proj 005 - 14 0000
Light traffic on Mulberry

Proj 011 - 2/8 overnight
12:15 -

Proj - 020 - 2/8 PM - Light Rain - 36F, 1735 - 1755
- several salt/sand trucks driving by - Snow Humidity - 93%
Wind - 5 MPH

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: MS/JS Date: 12/15
Site ID: M17 Address: 321 Fremont St
Land Use: ☒ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ________

Measurement Data SLM Model: 2250 ID # _____ Serial # ________

Weather: Temp (°F) ________ Wind ________ Humidity ________ Cloud Cover ________

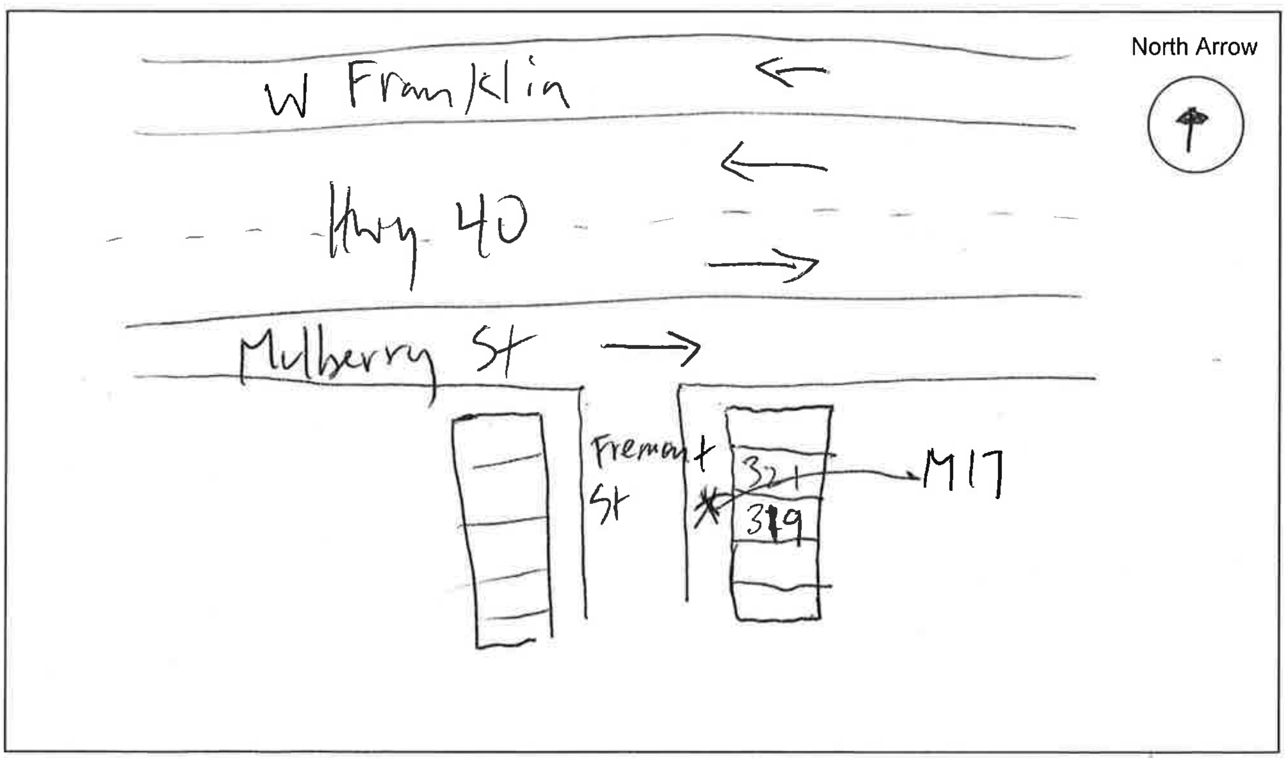
Proj 024

Time		Results				Calibration	
Start:	11:20	Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

11:25 - Police siren
Fremont/Mulberry unsignalized. Stop control on Fremont
Proj 025 - 4:15 12/15 PM count

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: JS&MS Date: 2/3

Site ID: M17 Address: Freemont / Mulberry

Land Use: ☒ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ______

Measurement Data SLM Model: ______ ID # ______ Serial # ______

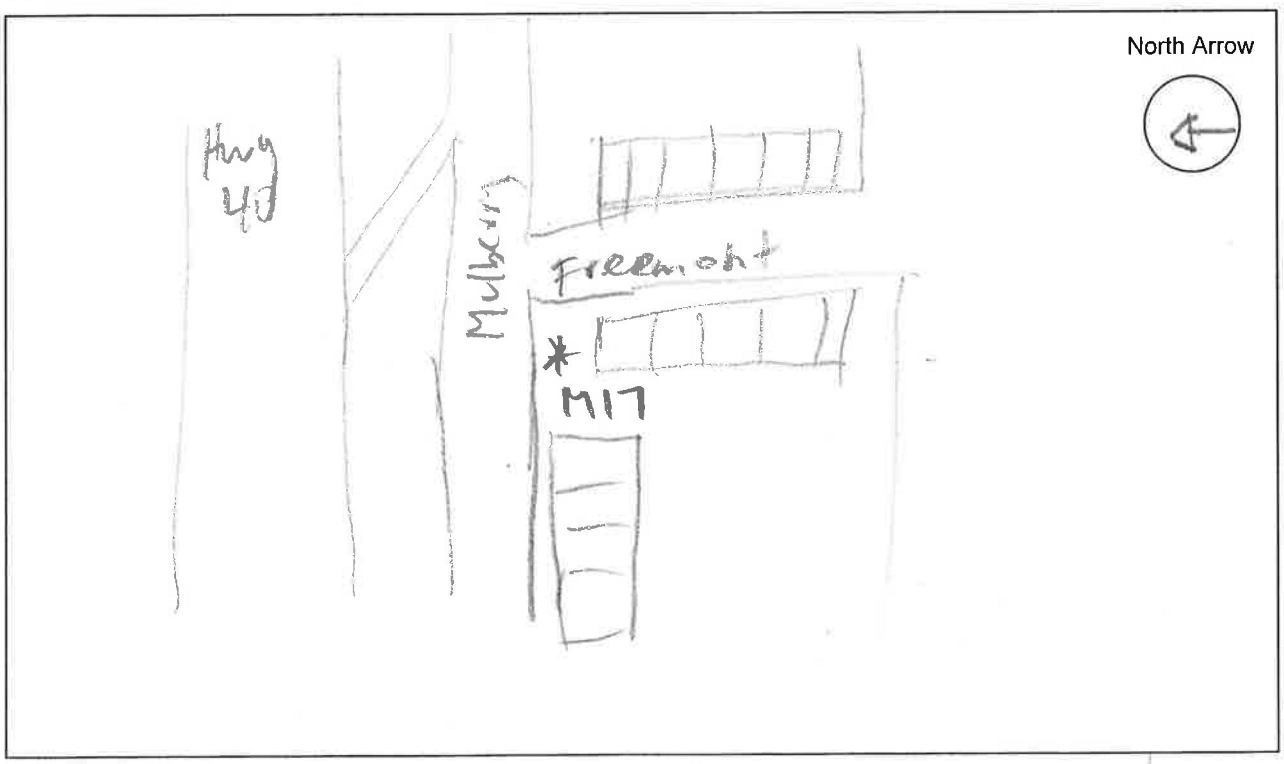
Weather: Temp (°F) 39 Wind 3MPH Humidity 62% Cloud Cover 40%

Time		Results				Calibration	
Start:	1230	Leq05min:		Lmax:		Before:	
Stop:	1250	Leq10min:		Lmin:		After:	
Total:	20 Min	Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Proj 012 12:30 AM
Little / No traffic on Mulberry

Site Sketch:



Noise Monitoring Data Sheet

Project: Baltimore Red Line Project Operators: JS&MS Date: 2/6/12

Site ID: M18 Address: 801 W Baltimore

Land Use: ❑ Residential ❑ Commercial ☒ Institutional ❑ Mixed ❑ Other ______

Measurement Data SLM Model: 2236 ID # 1 Serial # ______

Weather: Temp (°F) 45 Wind 2-4 Humidity 50% Cloud Cover 0

Time		Results				Calibration	
Start:	14:10	Leq05min:		Lmax:		Before:	
Stop:	15:00	Leq10min:		Lmin:		After:	2.0
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes: 70.9

BioPark

Bus traffic both directs Ambient noise low-mid 60s

Vibr PVS= 0.024 in/sec - 5-10 ft from bus - 5-10 MPH bus

14:05:07- Ambient - PVS: 0.023

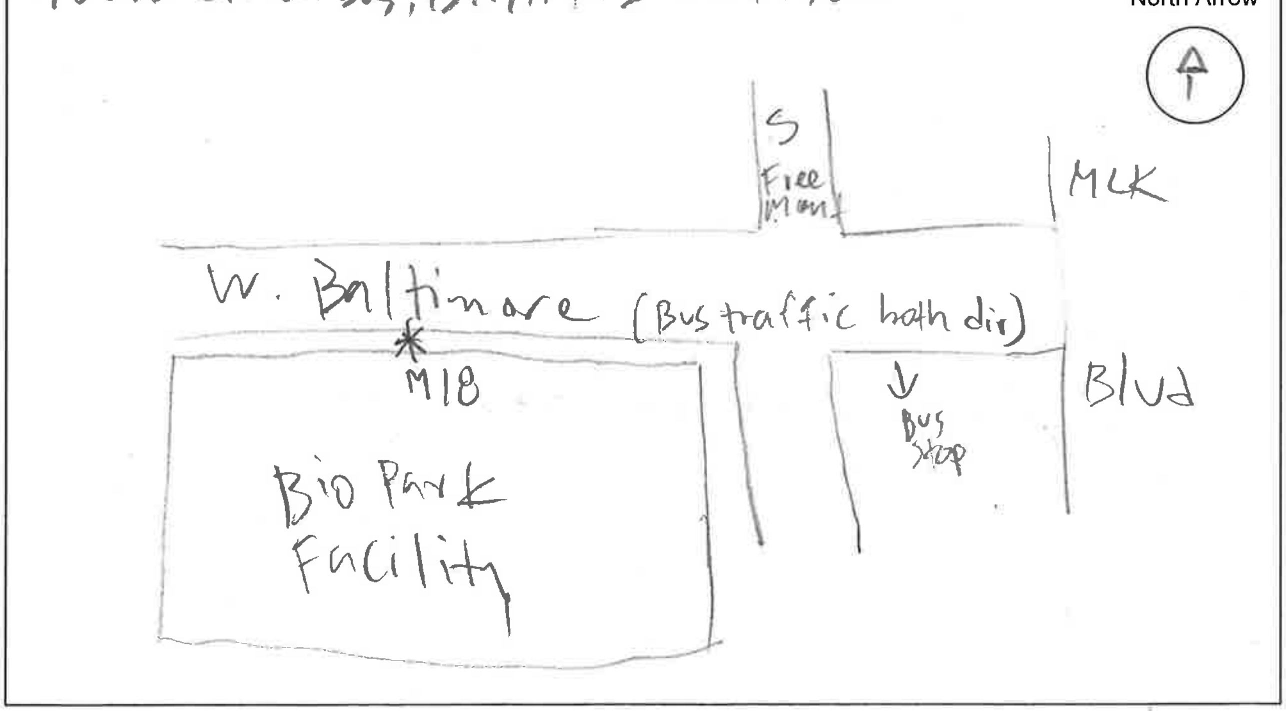
14 0448-car, 15 MPH, PVS: 0.023 in/sec

14 0416-diesel bus - 15 mph PVS: .024 in/sec

14 0401 diesel bus 15 mph PVS: .024 in/sec

Site Sketch: 140304- elec. bus 15 MPH PVS: 0.023 in/sec

140235- diesel bus, 15 MPH PVS .024 in/sec



Noise Monitoring Data Sheet

Proj 004

Project: *Baltimore Red Line Project* Operators: MS/JS Date: 12/13

Site ID: M19 Address: ________

Land Use: ❑ Residential ❑ Commercial ❑ Institutional ❑ Mixed ❑ Other ________

Measurement Data SLM Model: ________ ID # ______ Serial # ________

Weather: Temp (°F) ________ Wind ________ Humidity ________ Cloud Cover ________

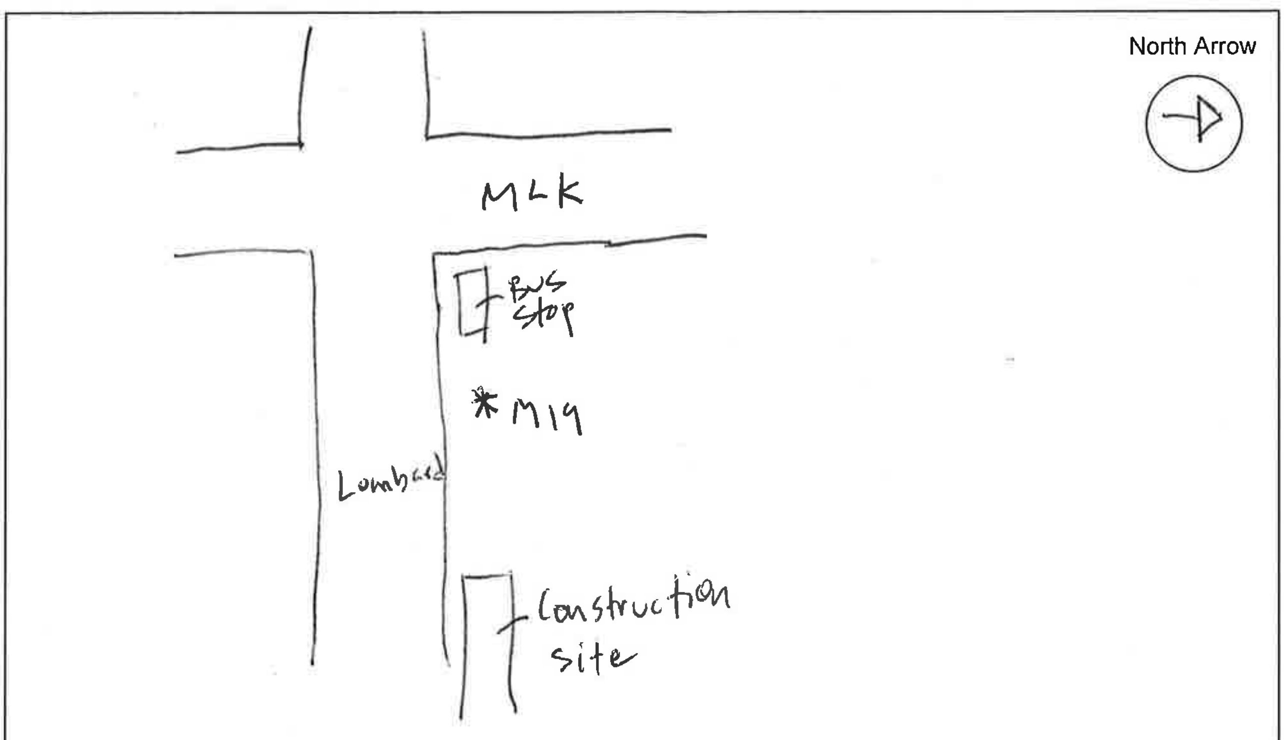
Time		Results				Calibration	
Start:	~~7:00~~ 7:15	Leq05min:		Lmax:		Before:	
Stop:	~~7:20~~ 7:35	Leq10min:		Lmin:		After:	
Total:	20	Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Moved M19 1/2 block west due to construction

Active bus lane

Site Sketch:



Noise Monitoring Data Sheet

Project: Baltimore Red Line Project Operators: JS&MS Date: 2/9
Site ID: M19 Address: Lombard & Penn St.
Land Use: ❑ Residential ❑ Commercial ☒ Institutional ❑ Mixed ❑ Other ________

Measurement Data SLM Model: ________ ID # _____ Serial # ________

Weather: Temp (°F) 41 Wind 12 Humidity 43% Cloud Cover 5%

Time		Results				Calibration	
Start:		Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

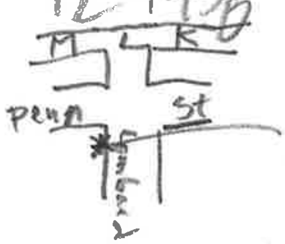
Vibration
122712 - .035 - Hvy truck (fire engine)
@ 10' - 15MPH

Bus idle @ 15 - Not triggering
122937 Bus accelerate @ 15' - 15MPH 0.030 in/sec

Site Sketch:

North Arrow

123233 - .025 in/sec, bus PB @ 20', 10 MPH (decellerating)
123608 0.040 Bus Accelerate @ 10', 20 MPH
123812 0.035 Lt truck Accelerate @ 10', 20 MPH
124058 .025 Bus circulator, electric @ 10', 10 MPH
124357 0.035, Heavy foot stomp @ 1'
124458 .030, lt truck accelerate @ 10', 20MPH



site chosen due to construction Activities

Noise Monitoring Data Sheet

Project: Baltimore Red Line Project Operators: JS&MS Date: 2/6/12

Site ID: M20 Address: Park Garage Culvert/Lombard

Land Use: ❑ Residential ❑ Commercial ❑ Institutional ❑ Mixed ☒ Other Parking/Trans

Measurement Data SLM Model: LD ID # 812 Serial # ______

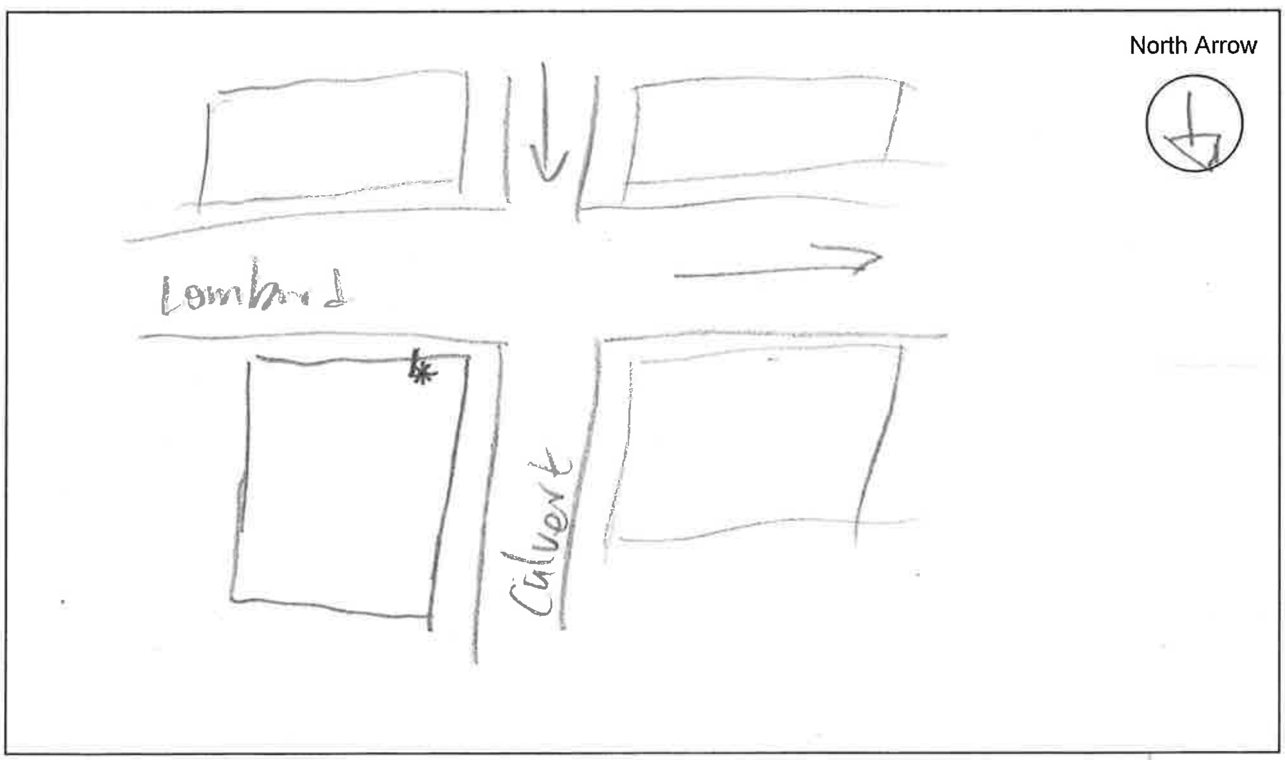
Weather: Temp (°F) 45 Wind ______ Humidity ______ Cloud Cover ______

Time		Results				Calibration	
Start:	1650	Leq05min:		Lmax:		Before:	
Stop:	1808	Leq10min:		Lmin:		After:	
Total:	25-16	Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

SLM inside garage, microphone poking through metal grate for security purposes.

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: JS&MS Date: 2/7/12

Site ID: M21 Address: Eastern/S President

Land Use: ☐ Residential ☐ Commercial ☒ Institutional ☐ Mixed ☐ Other ______

Measurement Data SLM Model: 2250 ID # ______ Serial # ______

Weather: Temp (°F) 54 Wind 8 Humidity 37% Cloud Cover 15%

Time		Results				Calibration	
Start:	1259	Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

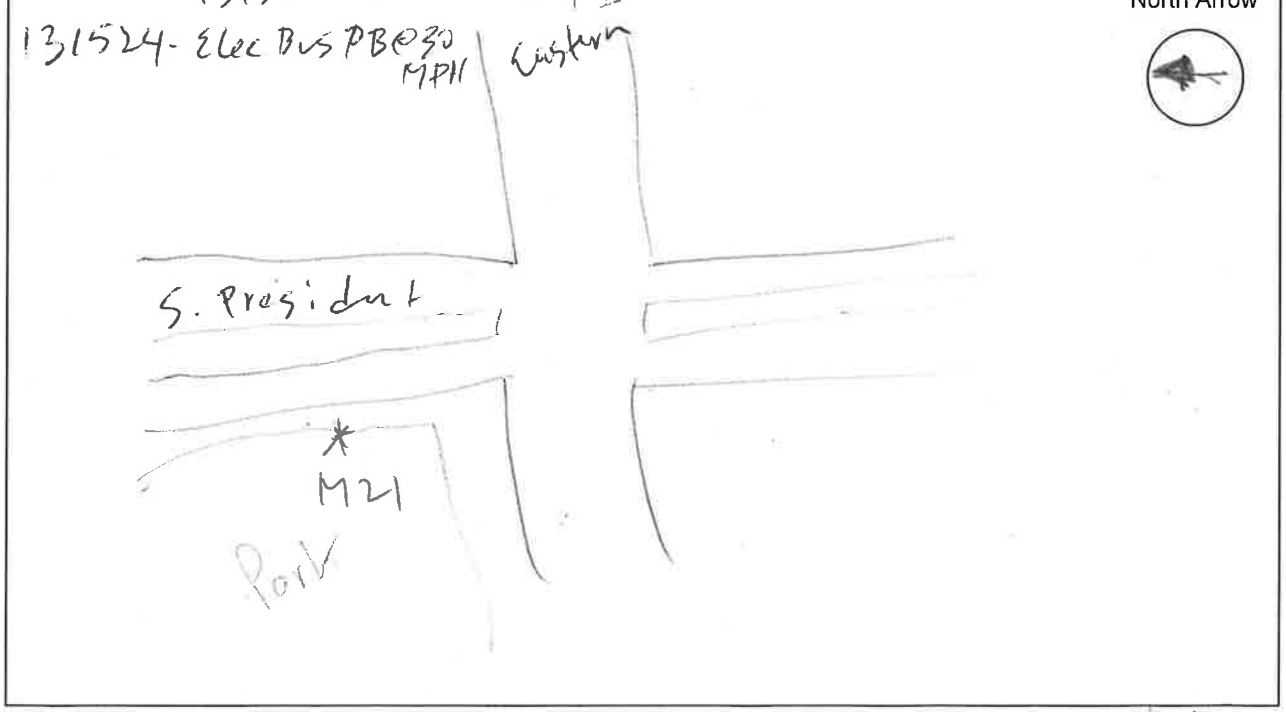
Notes:

Marko collected Vibration data independently

proj 003

130215 - Elec Bus PB @ 20'
130328 - Car horn
130613 - Elec Bus PB @ 20' - 25 MPH
130817 - Elec Bus PB & idle in front of SLM
130920 - Diesel bus PB @ 20'
130938 - Semi truck PB @ 20'

Site Sketch: 131237 - ~~Diese~~ Elec Bus idle & driveby
131300 - Semi truck PB
131524 - Elec Bus PB @ 30 MPH



See Reverse

Proj 009- PM peak 2/7 17:36 Start
17 56 Finish

Heavy traffic on President street

174000 Helicopter flyover

Proj 013 - Overnight 12 52 AM - 1:12 AM

Noise Monitoring Data Sheet

Project: Baltimore Red Line Project Operators: JS&MS Date: 2/7/12

Site ID: M22 Address: Central & AliceAnna

Land Use: ☐ Residential ☒ Commercial ☐ Institutional ☒ Mixed ☐ Other ______

Measurement Data SLM Model: 2250 ID # ______ Serial # ______

Weather: Temp (°F) 50 Wind 4 Humidity 30 Cloud Cover 0

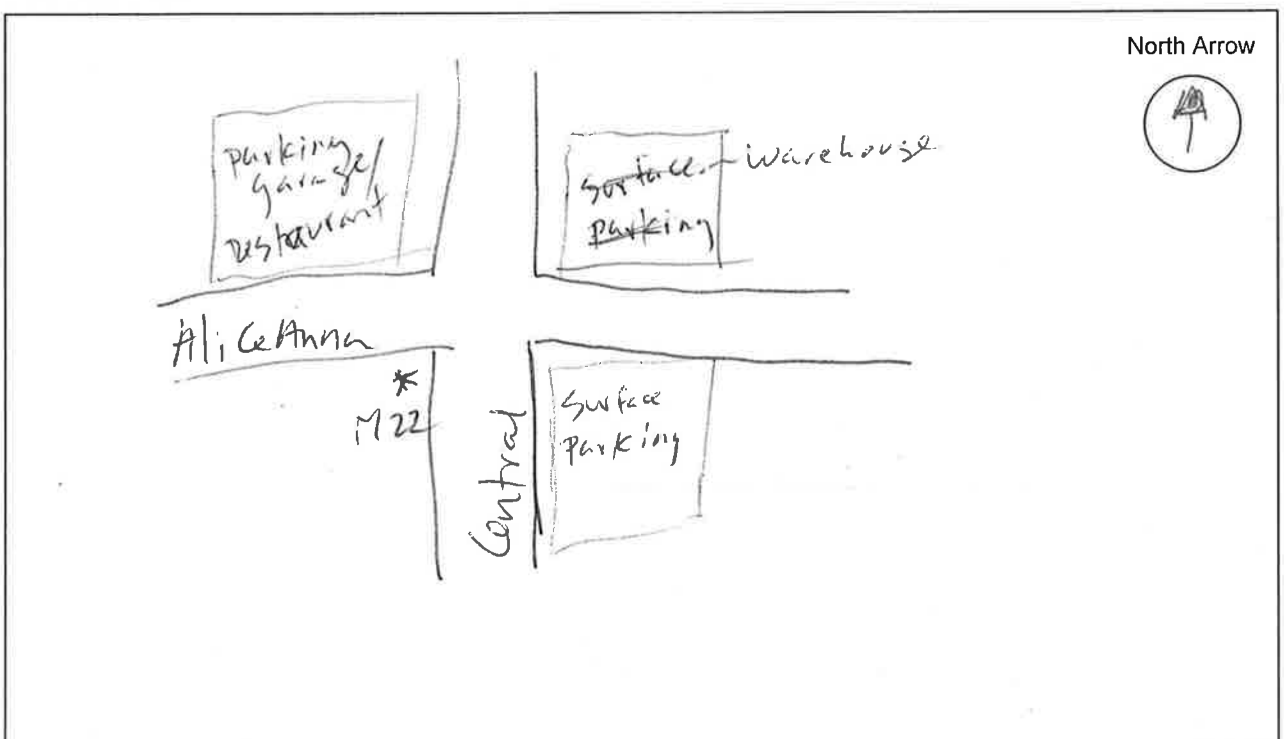
Time		Results				Calibration	
Start:	1226	Leq05min:		Lmax:		Before:	
Stop:	1246	Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Proj 002

Light traffic during MD count
123532 - Electric bus PB @ 15'
124007 - Electric buss PB @ 15'
124148 " " @ 35'

Site Sketch:



See reverse

Noise Monitoring Data Sheet

Project: Baltimore Red Line Project Operators: MS/JS Date: 12/15/11

Site ID: M23 Address: 1726 Fleet St

Land Use: ☒ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ________

Measurement Data SLM Model: 2236 ID # 2 Serial # ________

Weather: Temp (°F) 52 Wind SW6 Humidity 56 Cloud Cover 10%

Time		Results				Calibration	
Start:	9:45AM	Leq05min:		Lmax:		Before:	
Stop:	10:20	Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

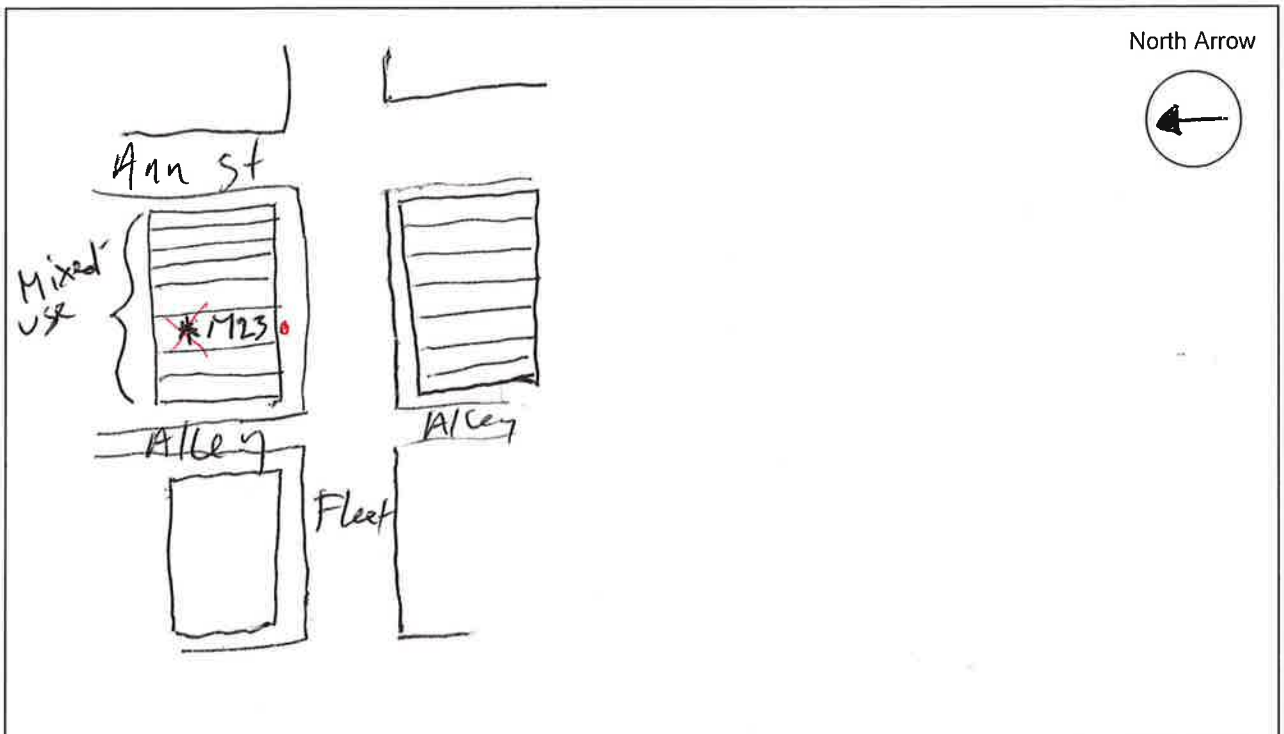
Notes:

Moderate AM traffic on Fleet St 67.9 Leq

Microphone moved to a slightly different position ~~may have~~

Mic 2 ft from facade.

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: JS&MS Date: 2/7/11

Site ID: M23 Address: ~~1726~~ 1725 Fleet St

Land Use: ☐ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ________

Measurement Data SLM Model: ________ ID # ______ Serial # ________

Weather: Temp (°F) 50 Wind 3-5 Humidity 30% Cloud Cover 0%

Time		Results				Calibration	
Start:		Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

Vibration

121055 - Semi truck passby @ 10' - 20MPH (121056 PVS= .023)

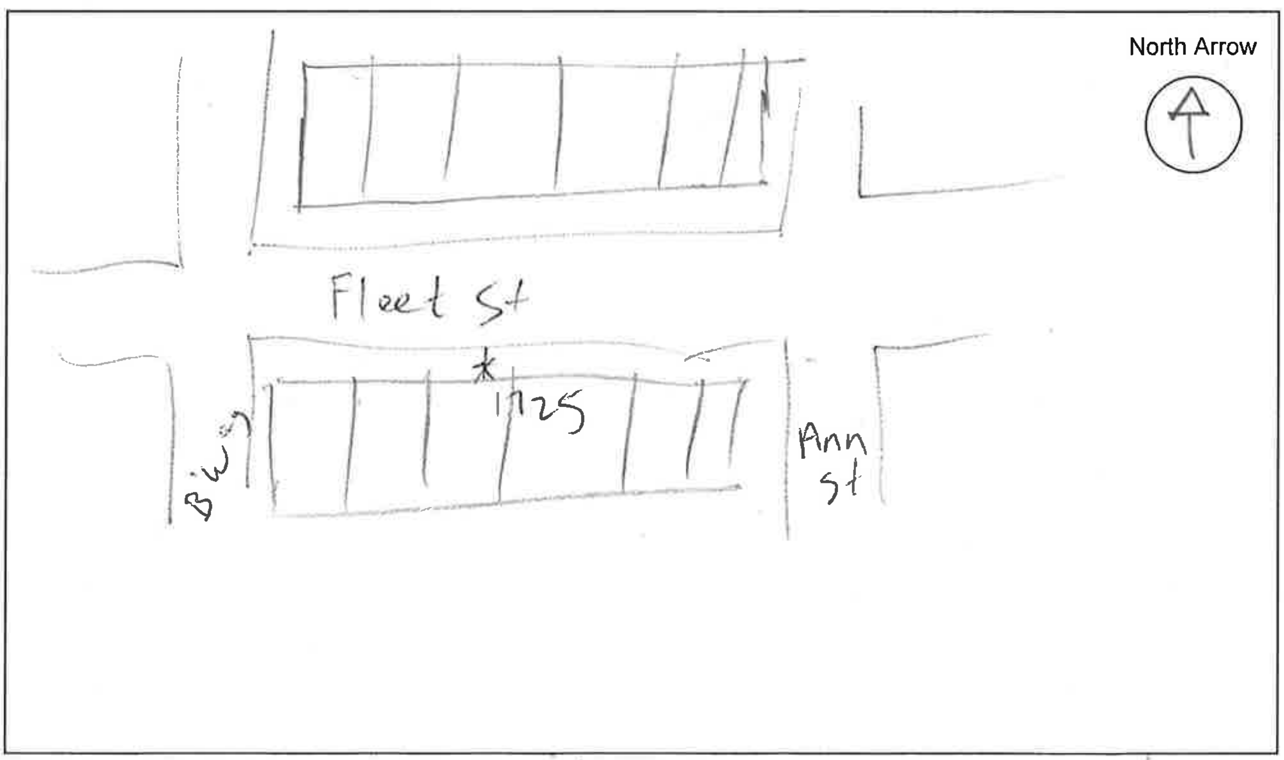
121240 - car passby @ 10' - 20MPH (121246 .023 in/sec)

121332 - bus pb @ 20' - 20MPH - diesel bus (121328 .023 PVS)

121440 heavy walk @ 3' (121430 PVS: .030)

121458 - Semi truck passby @ 10' - 20MPH (121501 PVS: .024 in/sec)

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: MS/JS Date: 12/15/11

Site ID: M24 Address: 2401-2403 Boston Street

Land Use: ☒ Residential ☐ Commercial ☐ Institutional ☐ Mixed ☐ Other ________

Measurement Data SLM Model: 2236 ID # 1 Serial # ________

Weather: Temp (°F) 52 Wind SW6 Humidity 56% Cloud Cover 10%

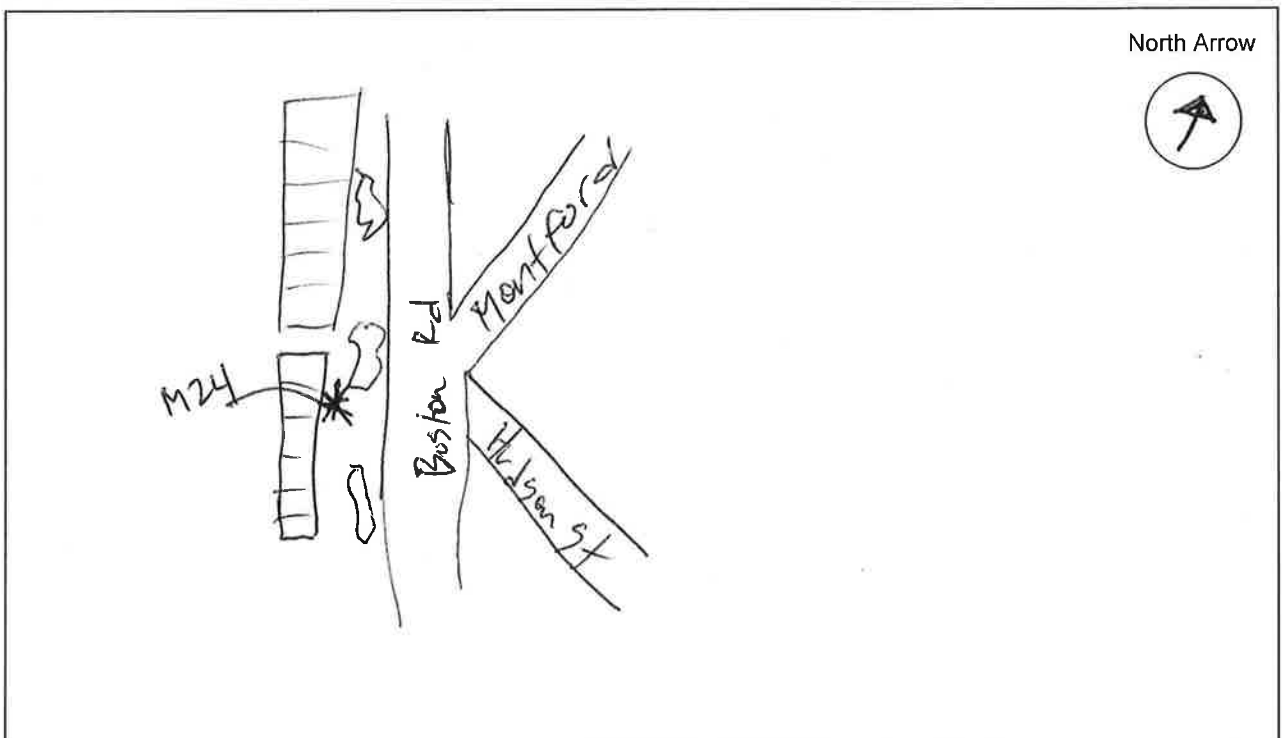
Time		Results				Calibration	
Start:	10:00	Leq05min:		Lmax:		Before:	
Stop:	10:26	Leq10min:		Lmin:		After:	
Total:	24:26	Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

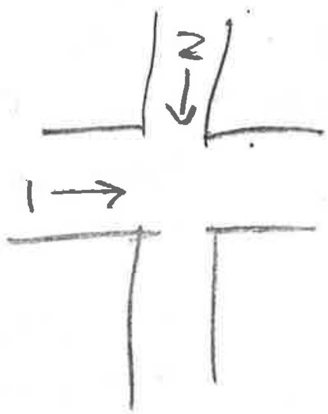
M24 setup 50' from Boston Rd.

61.9 Leq

Site Sketch:



traffic counts on 2/6/12



Franklin

Franklintown

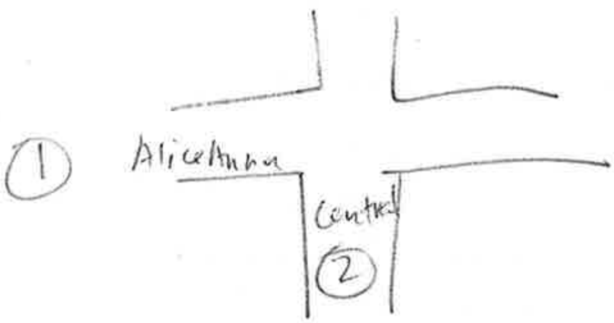
1- Franklin E-W
PC-460 HT-6
LT 24 Bus. 12

2. Franklintown ~~12~~ N-S
PC-118 HT-0
LT-8 Bus-4

Vib- Ambient 15-15-09
15-16-10 - Wave of traffic
15-18-50 - Bus idle @ 2' - < .025 in/sec (diesel)
15-19-35 Bus accelerate @ 3' .030 in/sec 10MPH-15
School bus @ 5' - 25MPH
15-21-35 - LT truck @ 10' 35MPH
15-29-00 Hvy Truck 30 MPH @ 30' < 0.022 in/sec

Proj 008- PM - 1707 - 1727

171050 - Helicopter overhead



1 (AliceAnna) - 148 car
0 LT
0 HT
0 Bus

2 (Central) - 280 car
2 LT
0 HT
0 Bus

S Central
NB/SB

AliceAnna
EB/WB

LT	HT
1	

LT	HT

Proj 013- 1:10 AM 2/8 overnight
1:30

Little/No traffic present

Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: JS&MS Date: 2/6/12

Site ID: M24 Address: 2413 Boston Rd

Land Use: ☒ Residential ❑ Commercial ❑ Institutional ❑ Mixed ❑ Other ______

Measurement Data SLM Model: LD ID # 820 Serial # ______

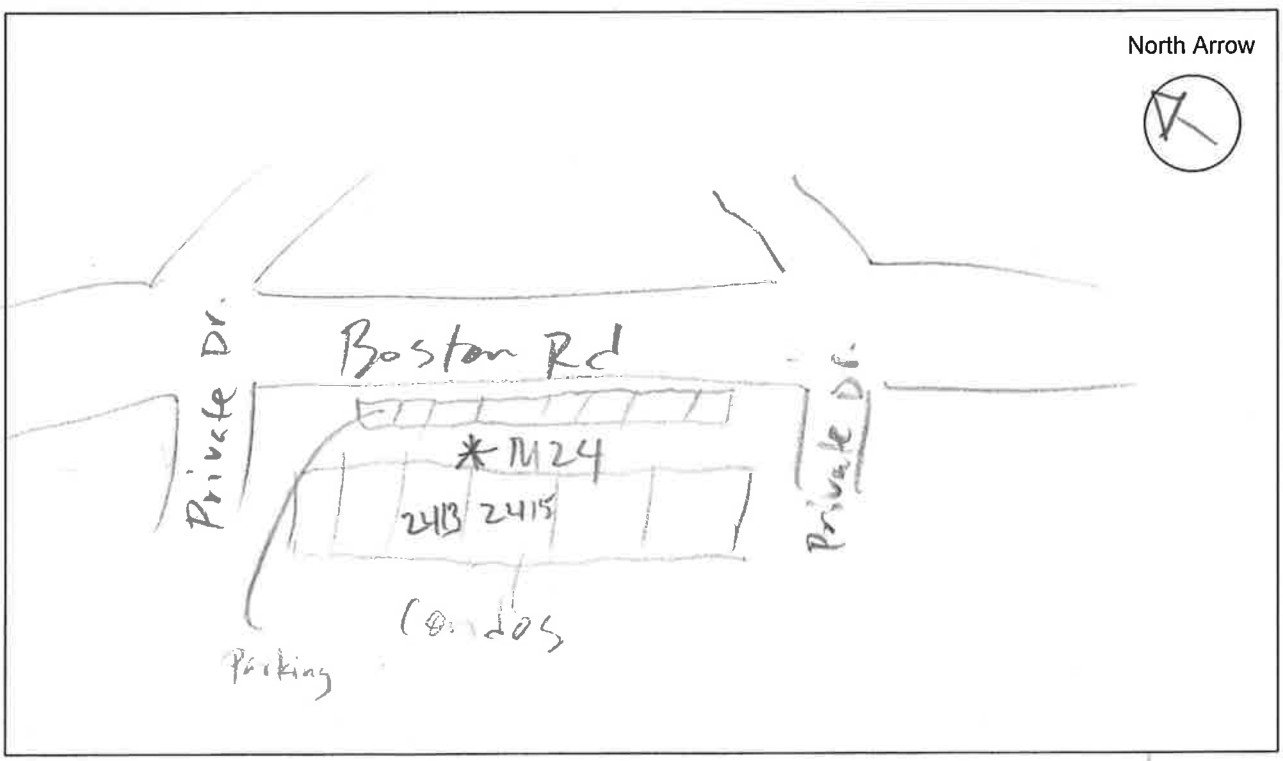
Weather: Temp (°F) 40 Wind — Humidity 40% Cloud Cover 5-10

Time		Results				Calibration	
Start:	1720	Leq05min:		Lmax:		Before:	
Stop:	18-28	Leq10min:		Lmin:		After:	
Total:	25-08	Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes: Lq -60.5

Placed 12' from building facade.
Moderate traffic on Boston Rd LOS-C

Site Sketch:



Noise Monitoring Data Sheet

Project: _Baltimore Red Line Project_ Operators: JS&MS Date: 2/8

Site ID: M25 Address: Corner of Boston / Potomac

Land Use: ☒ Residential ❑ Commercial ❑ Institutional ☒ Mixed ❑ Other

Measurement Data SLM Model: 2250 ID # Serial #

Weather: Temp (°F) 40 Wind — Humidity — Cloud Cover

Time		Results				Calibration	
Start:	1:30AM	Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

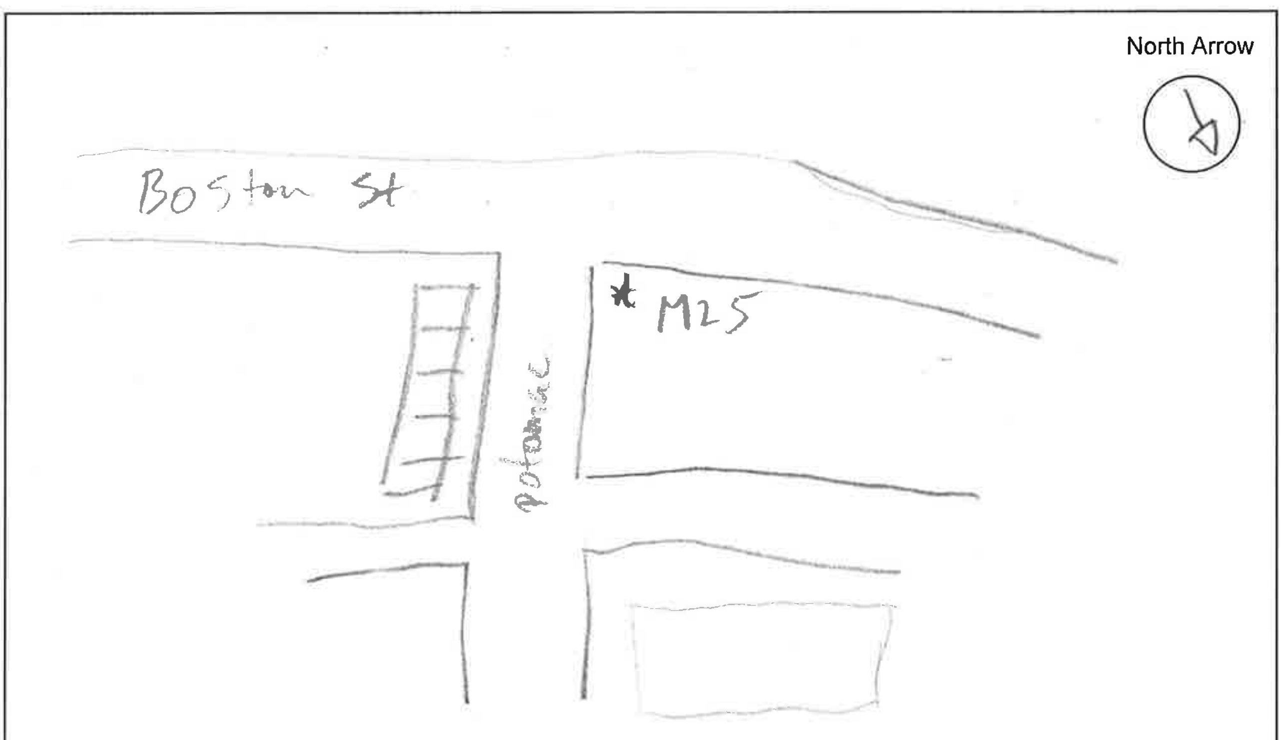
Notes:

Proj 014 Minimal traffic on Boston St during overnight ...

Proj 018 1410 - Moderate traffic on Boston St. Not snowing/raining
several heavy trucks on Boston. 14:16

Proj 019 - 1612 2/8
1632

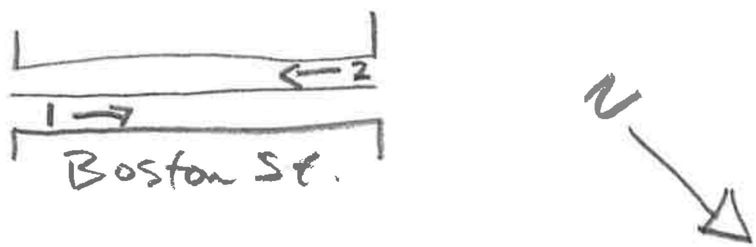
Site Sketch:



See Reverse

	PC	LT	HT	Bus
1.	189	6	2	1
2.	283	10	2	1

Posted speed limit
30MPH
4:15-4:35 PM
2/8



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: JS&MS Date: 2/7/12

Site ID: M26 Address: Boston Rd

Land Use: ❑ Residential ❑ Commercial ❑ Institutional ❑ Mixed ❑ Other ________

Measurement Data SLM Model: ________ ID # 2 Serial # ________

Weather: Temp (°F) 45 Wind 8MPH Humidity 38% Cloud Cover 40%

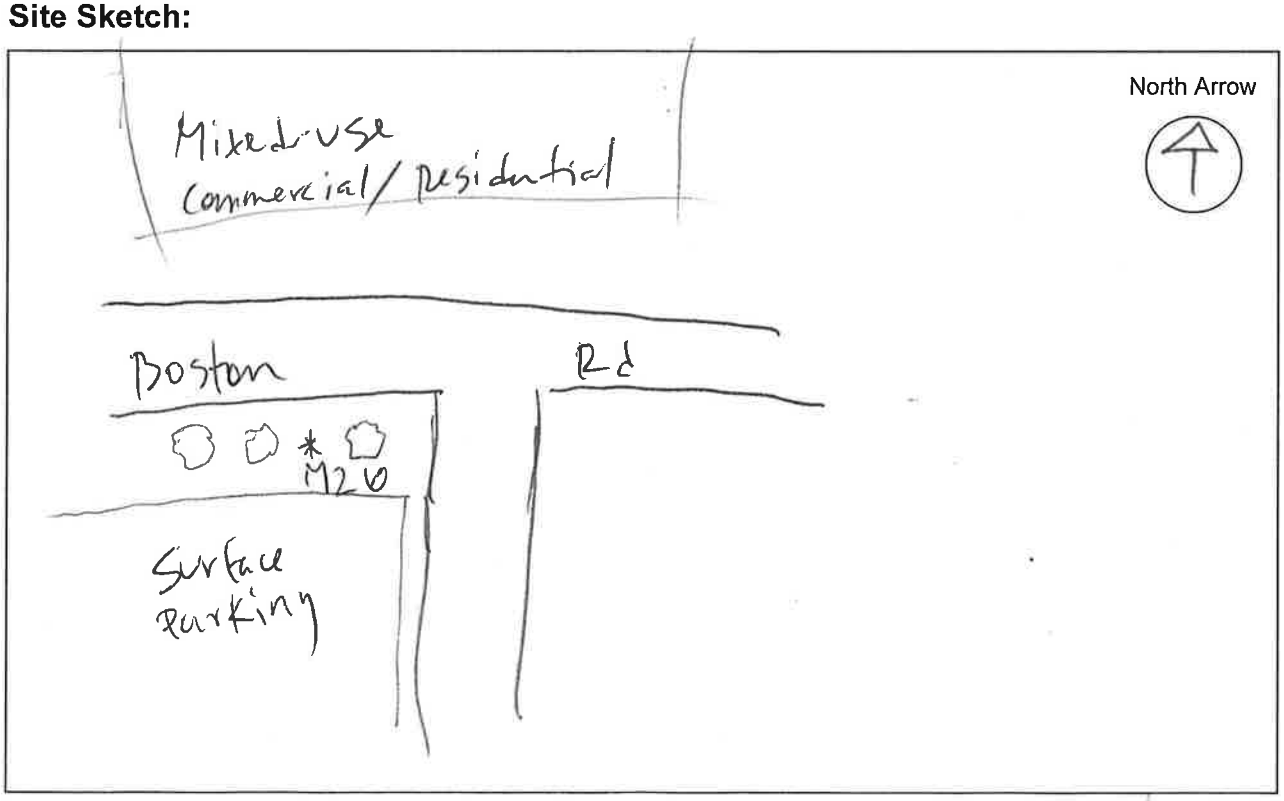
Time		Results				Calibration	
Start:	1650	Leq05min:		Lmax:		Before:	
Stop:		Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Take pictures

Notes:

Started snowing around 1pm 2/8/12

Site Sketch:



Noise Monitoring Data Sheet

Project: *Baltimore Red Line Project* Operators: JS&MS Date: 2/7/12

Site ID: M27 Address:

Land Use: ☐ Residential ☐ Commercial ☒ Institutional ☐ Mixed ☐ Other

Measurement Data SLM Model: 2236 ID # 1 Serial #

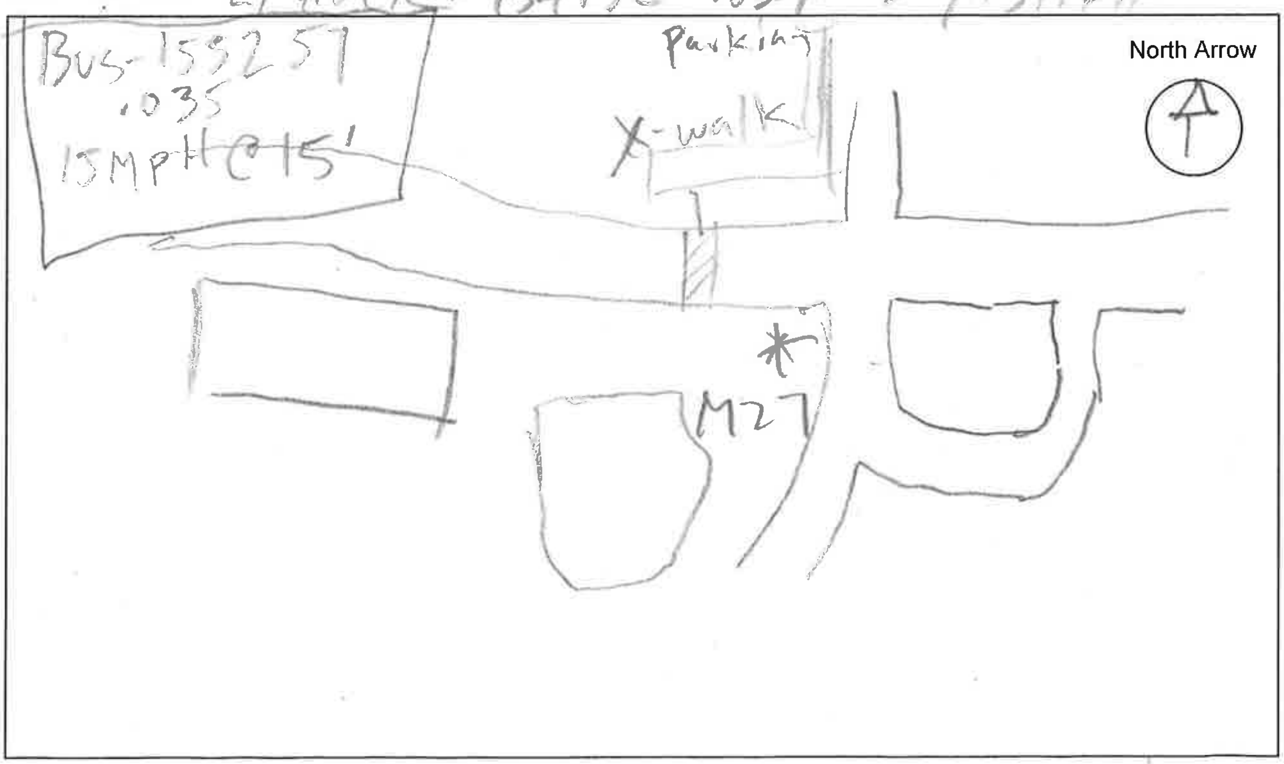
Weather: Temp (°F) 45 Wind 6MPH Humidity 40% Cloud Cover 0

Time		Results				Calibration	
Start:	1600	Leq05min:		Lmax:		Before:	
Stop:	1555	Leq10min:		Lmin:		After:	
Total:		Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:
Slow moving traffic.
started snowing 1pm 2/8/12

Vibration. 3:35 PM 2/8 Ambient .022
LT truck. 154321. .029. 5', 15MPH
Car passing - .024
Lt truck - 154732 - .037 - 5', 15MPH

Site Sketch:



Noise Monitoring Data Sheet

Project: Baltimore Red Line Project   Operators: JS&MS   Date: 2/7

Site ID: M28   Address: E Lombard

Land Use: ❑ Residential ❑ Commercial ☒ Institutional ❑ Mixed ❑ Other ________

Measurement Data   SLM Model: 2250   ID # ____   Serial # ________

Weather: Temp (°F) 50   Wind 0   Humidity 39%   Cloud Cover 30%

Time		Results				Calibration	
Start:	1612	Leq05min:		Lmax:		Before:	
Stop:	1632	Leq10min:		Lmin:		After:	
Total:	20	Leq15min:		L10:		Ref:	94.0
		Leq20min:		L90:		Model:	

Notes:

proj 007.

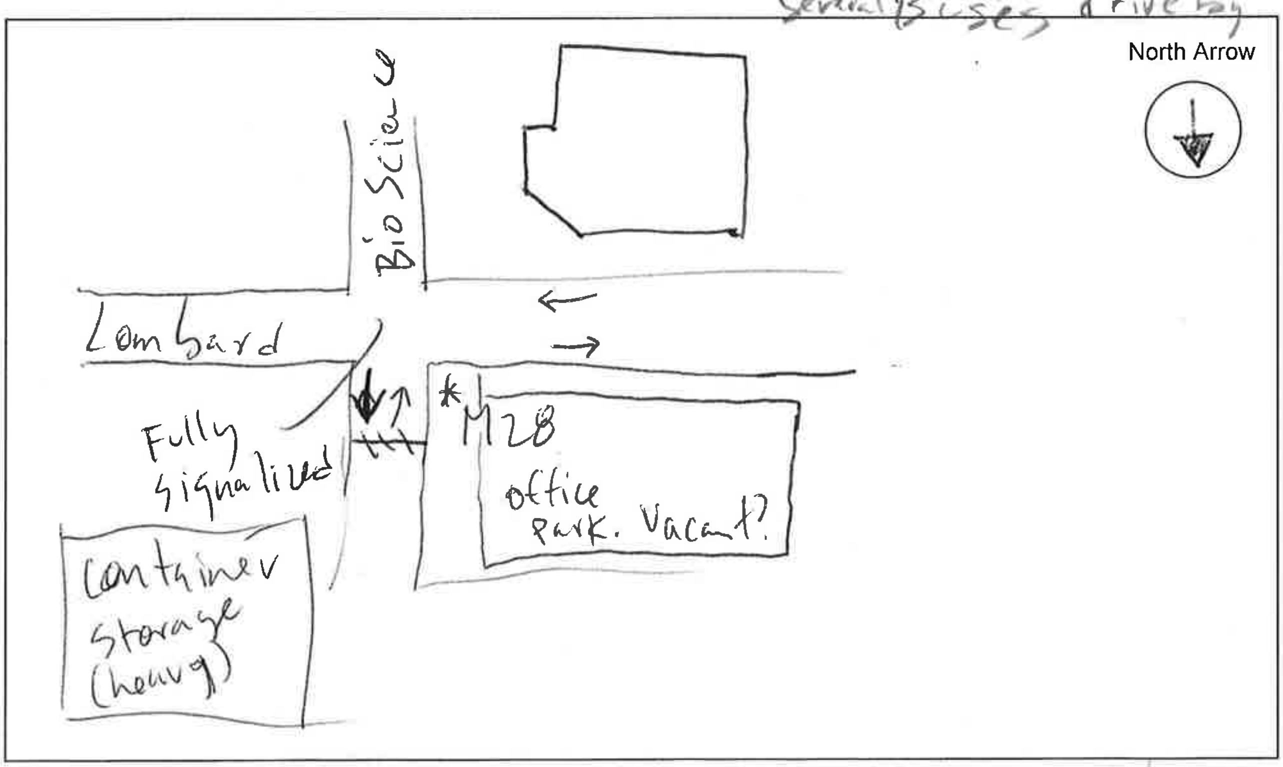
medium traffic Flow. Some heavy truck traffic.

Proj 015 - (016?)

1:52 AM 2/8 - NO traffic. Airbrake) hissing Noise occasionally @ container area. Infrequent; Doesn't Interfere

several Buses drive by

Site Sketch:



See reverse

Proj 017. 1335 2/8/12
Light wet snow. 35F, 100% cloud cover
Some Heavy truck traffic.

Leq-72. , Recal, -.11 deviation.
Insignificant

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
MARYLAND TRANSIT ADMINISTRATION

Baltimore, Maryland

Baltimore Red Line
Red Line General Engineering Consultant

Operating Plan Technical Report
December 2012

Document No.
1725

Table of Contents

ES. Executive Summary

An Operating Plan is a highly detailed description of rail operations on a given line or network that may include (but is not necessarily limited to) such data as: specific arrival and/or departure times at each passenger station for each train (also called "the Schedule"), passing times at significant timing points on the railroad such as interlockings and control points, train routing information (entry and exit tracks at each merge/diverge point), rail equipment dispositions (turns, yarding, non-revenue movements, and so forth), and other information. These separate elements, when used together, detail the means necessary to provide the desired service.

A Service Plan is a summary-level description of rail operations that is desired to operate on a given line or network. It is usually expressed in terms of headway or trains per hour for defined operating periods (for example, AM Peak, Midday, PM Peak, and Evening/Overnight). It includes train frequency and stopping patterns, but does not include specific details of how this service would be provided. It provides the framework upon which the Operating Plan is subsequently developed.

The purpose of this Operating Plan is to demonstrate, based on the information available at this time, how trains would be operated on the Red Line on opening day in 2021 and also in the horizon year of 2035. At this stage, the concepts of the Service Plan and individual train schedules have been developed.

To date, single train simulations have been performed under a variety of conditions to determine running times and, from that, cycle times. Headways, often developed from calculation of the system maximum load points in different time periods, are used in conjunction with cycle times to determine fleet requirements. Addressed in this plan at this stage are headways, travel times and vehicle requirements, as well as the methodology employed to determine them. When schedule development is completed, a full network simulation would be performed and the final operating plan completed.

Based on the existing ridership forecast's maximum load point estimation of 1,713 passengers for 2020, the planned peak headway for opening day operation in 2021 has been established as 10 minutes. Though the maximum load point forecast for 2035 of 1,777 passengers does not require it, at this time it is planned to operate on 7-minute headways in 2035 in order to provide additional service opportunities.

Because of the effects of traffic signals on the portion of the Red Line that operates within existing roadways, it was determined that the impact of traffic signal-related delays should be integrated into the standard rail simulation model to reflect realistic light rail operations through the street-running segments. This hybrid approach combined a range of traffic signal delays, as determined by the VISSIM traffic simulation model, with travel time results determined by Rail Traffic Controller (RTC), a traditional rail operating model.

The output from the VISSIM model was used as an input to the RTC model. Travel times were generated which included vehicle characteristics, randomized traffic signal delays, limiting speeds, grades, curves and station stops. Five randomized single-train simulations for both an eastbound and westbound train were performed by RTC. Eastbound running times ranged from 43:19 to 45:19, with an average eastbound running time of 44:19. Westbound running times ranged from 45:12 to 46:33, with an average westbound running time of 45:38. An estimated travel time of 45 minutes was selected for use in generating cycle times and vehicle requirements. Using a 45-minute run time and 6 minutes of turn/recovery time at each terminal, the cycle time was calculated to be 102 minutes.

A total of 22 in–service vehicles would be required to provide service at 2021 levels. Though at the spare ratio levels calculated (12, 15 and 20 percent), the requirement was under six in all cases; it is recommended that a minimum of six spare cars be procured for a fleet of this size, which brings the total vehicle requirement for opening day to 28.

A total of 30 in–service vehicles would be required to provide service at 2035 levels. At some of the spare ratio percentages calculated for 30 cars the requirement was less than six. It is similarly recommended that a minimum of six spare cars (20 percent) be procured for a fleet of this size, which brings the total vehicle requirement for the year 2035 to 36.

1. Introduction

The Red Line project's Preferred Alternative is a 14.1-mile light rail transit line that would operate from the Centers for Medicare & Medicaid Services (CMS) in Baltimore County to the Johns Hopkins Bayview Medical Center campus in Baltimore City. The Preferred Alternative extends through the areas of Woodlawn, Edmondson Village, West Baltimore, downtown Baltimore, the Inner Harbor, Harbor East, Little Italy, Fell's Point, Greektown/Highlandtown, Canton and the Johns Hopkins Bayview Medical Center campus. The system would 'stub end' at the east and west end terminals.

The purpose of the Red Line project is to provide an additional transportation alternative through the densely populated areas of Baltimore City and Baltimore County. The system is to be accessible, efficient and safe, and fully integrated with existing regional transit services.

Studies forecast daily ridership on the system to be approximately 55,407 trips per weekday day in 2035. Monday through Saturday, Red Line service would operate 20 hours per day from 5:00 AM to 1:00 AM, and on Sundays from 10:00 AM to 10:00 PM. Peak periods are defined as weekdays between the hours of 6:00 AM and 9:00 AM, and 3:30 PM to 6:30 PM. All other service is considered to be off-peak.

1.1 Purpose

The purpose of the Red Line Operating Plan is to demonstrate how trains would operate on opening day (2021) and in the horizon year (2035) on the Red Line Light Rail System. The network simulation of the Red Line, when complete, would quantify travel time, capacity and reliability of the current design and confirm that changes made to this point support the overall project capacity goals.

1.2 Background

The first-to-last-station travel time established during the Red Line Alternative Analysis/Draft Environmental Impact Statement (AA/DEIS) planning phase was determined to be 44 minutes, 5 seconds. The travel time served as an input into the light rail vehicle fleet size assessment and ridership projection modeling, which contributed to establishing the project Cost Effective Index (CEI). This initial travel time was calculated using a spreadsheet model, a typical methodology used for planning-level run-time studies. Using the design alignment available at the time, the study was performed by identifying distance between stations, civil restrictions and authorized speeds. Calculations were then made to determine approximate run times between stations. In addition, an assumed level of delay was added to the calculations to account for estimated traffic delays and station dwell times. This type of study does not account for vehicle characteristics or the impacts of grades and curves on train operations.

As the Red Line project advances into the Final Environmental Impact Statement (FEIS) and Preliminary Engineering (PE) phases, the Red Line General Engineering Consultant (GEC) has been tasked with providing an updated and more precise travel time estimate. The travel time estimate provides the basis for other updated assessments, such as cycle time and fleet requirements, which further define projected peak hour ridership requirements. The updated travel time estimate is also required to revise travel demand/ridership forecasts, to reflect the current project alignment as it responds to changing project conditions, and capturing operating characteristics of the light rail system, including anticipated light rail vehicle performance, as they become more fully defined.

1.3 References

Draft Final Definition of Alternatives and Operating Plans, Version 3, April 21, 2010.
MTA Red/Purple Line Light Rail Design Criteria Revision 3, February 2012.
Red Line Travel Times Technical Report, Version 0, dated February 10, 2012.

1.4 List of Acronyms

AA	Alternatives Analysis
ACD	Advanced Conceptual Design
CBD	Central Business District
CEI	Cost Effective Index
CMS	Centers for Medicare and Medicaid Services
CLRL	Central Light Rail Line
DEIS	Draft Environmental Impact Statement
FEIS	Final Environmental Impact Statement
GEC	General Engineering Consultant
LPA	Locally Preferred Alternative
LRCC	Light Rail Control Center
LRO	Light Rail Operator
LRT	Light Rail Train
MARC	Maryland Area Regional Commuter Service
MTA	Maryland Transit Administration
OCS	Overhead Contact System
OMF	Operations and Maintenance Facility
O/P	Off-peak
P	Peak
PE	Preliminary Engineering
RTC	Rail Traffic Controller (Software)
TPSS	Traction Power Substation
VMS	Vehicle Management System

2. The Preliminary Engineering Alignment

The basis of the Preferred Alternative alignment is the October 25, 2010 Advanced Conceptual Design (ACD) submission, which served as a record of the refinements to the Locally Preferred Alternative (LPA). The Alignment has been further refined since October 25, 2010 based on continued engineering studies, public input, and continued environmental analysis.

The project corridor was established as a west-east rail line connecting the Centers for Medicare & Medicaid Services (CMS) in Baltimore County with the Johns Hopkins Bayview Medical Center campus in East Baltimore. The corridor winds through sections of West Baltimore and the downtown central business district (CBD).

The current PE design includes the following infrastructure elements:

- A full, double track alignment beginning at the west end at the CMS terminal station and ending at the east end at Bayview MARC terminal station
- Tail tracks located at both the CMS and Bayview MARC terminals
- An Operations and Maintenance Facility (OMF) at a proposed Calverton Road site, the current design of the OMF would allow for storage of up to 38 light rail vehicles
- A traction power system including overhead contact system (OCS) and traction power substations (TPSSs)
- Nineteen stations – 14 at surface level and five underground
- A civil design maximum speed of 55 miles per hour (MPH)
- Universal mainline crossovers located to allow 10-minute single-track operation, where practicable
- Two tunnel segments - the Downtown Tunnel and the Cooks Lane Tunnel
- Four aerial structures: I-695, Woodlawn Drive, Ingleside Avenue, NS/CSX/I-895
- Three proposed park-and-ride lots, at the following stations: Security Square, I-70 Park-and-Ride, and Brewers Hill/Canton Crossing
- One existing park-and-ride lot at West Baltimore MARC
- One proposed park-and-ride lot by the City at the proposed Bayview MARC station

See **Appendix A** for map of the proposed Red Line Preferred Alternative.

3. Operating Plan Assumptions

The development of the Red Line Operating Plan required the project team to set a number of assumptions upon which to build the plan. The basic assumptions as established are as follows:

- Peak headways at Opening Day (2021) service levels would be 10 minutes
- Peak headways at Horizon Year (2035) service levels would be 7 minutes
- All trains would stop at all stations
- Station dwell times would be either 15 seconds or 20 seconds, depending upon the forecasted ridership at the specific station
- Terminal turn/recovery time would be not less than 6 minutes during peak periods and not less than 10 minutes during off-peak periods
- No other rail service would operate on or crossover the alignment
- Light Rail Operator (LRO) change points would be at a passenger station
- All vehicles would be stored and serviced at the Calverton OMF
- Vehicle requirements meet current design criteria for acceleration and deceleration
- Trains departing and returning to the OMF would carry passengers between the yard and initial terminal
- The system would utilize a cab signal system in all areas other than locations of embedded track
- Universal mainline crossovers would be located to allow 10-minute single-track operation, where practicable
- Platform heights would be 14 inches above top of rail and vehicles would have low level floors
- Tail tracks would be provided at east and west end terminals
- Existing 2020 ridership figures are applicable to 2021 opening day conditions

4. Rolling Stock

4.1 Introduction

Rolling stock for the Red Line project has not yet been selected. The standards and design requirements of the basic functional, operational, and physical requirements of the low-floor light rail vehicle for use on the Baltimore Red Line system have been established and are documented in Chapter 17 of the *Maryland Transit Administration Red/Purple Light Rail Design Criteria Revision 3*. The data provided in that document is intended to provide sufficient information to allow design development during the system engineering phase and creation of estimates of capital, operating, and maintenance costs. That document would form the basis of design for the preliminary development of the rail passenger vehicle technical provisions and the associated system design.

4.2 General Information

The vehicle would be articulated and have a low floor that allows level boarding from low level station platforms. Maximum length of a single vehicle would not exceed 97 feet, or 194 feet for two vehicles coupled. Each vehicle would have a minimum of four doors on each side to allow rapid loading and unloading. The vehicle would comply with Americans with Disabilities Act (ADA) requirements for light rail vehicles as defined in 49 CFR 38, Sections 38.71 through 38.87, especially pertaining to boarding and alighting. There shall be a minimum of 66 passenger seats including tip-ups (with a preference for 72 or more seats), four wheelchair positions and four bicycle positions per vehicle. Each vehicle would have standing space for a minimum of 106 passengers (with a preference for 120 standees).

The vehicle shall be bi-directional, with full operating cabs at each end. Communications would be controlled by an integrated Vehicle Management System (VMS) and shall include voice and data radios, a GPS system, public address system (with cab-to-cab intercom and passenger-to-operator intercom stations), exterior destination displays, interior variable message passenger information displays, automatic passenger counters and an auto-announcer. The VMS system would also communicate with the Red Line Light Rail Control Center (LRCC) and provide automatic vehicle identification, text messaging, vehicle location, and transmission of operator initiated silent/emergency alarms, as well as control of the on-board flange lubrication system.

Video monitoring shall also be supplied to include external platform/rear view video cameras and vehicle interior passenger area video monitoring and recording. A cab signaling system, train-to-wayside communication system and event recorder would also be provided.

4.3 Vehicle Performance Characteristics

For vehicle performance characteristics, including tractive effort curves, braking profile, and other criteria that were used to create the simulation model, see Chapter 17 of the *MTA Red/Purple Line Light Rail Design Criteria Revision 3.*

5. Service Plan

The Red Line would operate Monday through Saturday from 5:00 AM to 1:00 AM, and from 10:00 AM to 10:00 PM on Sundays.

Headways in 2035 would be between 7 minutes and 15 minutes, depending upon time of day. Headways in 2021 would be between 10 minutes and 15 minutes. The operating schedule currently under development would accommodate 55,407 daily riders in 2035.

All trains would consist of two light rail vehicles. Each train would be staffed with one train operator. Station platforms would accommodate two-car trains.

5.1 Train Volumes

See **Table 1** below for the proposed number of trains per day broken down by hour. See **Table 2** for the proposed number of trains to run per operating period (e.g., peak, off-peak, etc.). The data may change as the operating plan is further developed.

Table 1: Proposed Number of Trains Per Hour and Per Day (2021)

Monday through Saturday		Sunday	
5:00 AM to 6:00 AM	8 O/P	5:00 AM to 6:00 AM	-
6:00 AM to 7:00 AM	12 P	6:00 AM to 7:00 AM	-
7:00 AM to 8:00 AM	12 P	7:00 AM to 8:00 AM	-
8:00 AM to 9:00 AM	12 P	8:00 AM to 9:00 AM	-
9:00 AM to 10:00 AM	12 O/P	9:00 AM to 10:00 AM	-
10:00 AM to 11:00 AM	12 O/P	10:00 AM to 11:00 AM	12
11:00 AM to 12:00 PM	12 O/P	11:00 AM to 12:00 PM	12
12:00 PM to 1:00 PM	12 O/P	12:00 PM to 1:00 PM	12
1:00 PM to 2:00 PM	12 O/P	1:00 PM to 2:00 PM	12
2:00 PM to 3:00 PM	12 O/P	2:00 PM to 3:00 PM	12
3:00 PM to 4:00 PM	6 O/P,6/P	3:00 PM to 4:00 PM	12
4:00 PM to 5:00 PM	12 P	4:00 PM to 5:00 PM	12
5:00 PM to 6:00 PM	12 P	5:00 PM to 6:00 PM	12
6:00 PM to 7:00 PM	6O/P,6/P	6:00 PM to 7:00 PM	12
7:00 PM to 8:00 PM	12 O/P	7:00 PM to 8:00 PM	12
8:00 PM to 9:00 PM	12 O/P	8:00 PM to 9:00 PM	12
9:00 PM to 10:00 PM	8 O/P	9:00 PM to 10:00 PM	12
10:00 PM to 11:00 PM	8 O/P	10:00 PM to 11:00 PM	1
11:00 PM to 12:00 AM	8 O/P	11:00 PM to 12:00 AM	-
12:00 AM to 1:00 AM	8 O/P	12:00 AM to 1:00 AM	-
Total per weekday/Sat	**220**	**Total Sunday**	**145**

Notes: Train counts per hour are based on terminal departure times
O/P = Off-Peak; P = Peak

Table 2: Number of Trains Per Time Period (2021)

Time Period	Trains
AM Peak	36
PM Peak	36
Off-peak	148
Full Weekday/Sat.	220
Sunday	145

5.2 Operating Headways

Headway is a measurement of the distance/time between vehicles on a transit line. The precise definition varies depending on the application, but it is most commonly measured as the distance from the tip of one vehicle to the tip of the next one behind it, expressed as the time it would take for the trailing vehicle to cover that distance. A "shorter" headway signifies more frequent service.

Headway is a key input in calculating the overall capacity of a transit line. A line that requires longer headways would have lower capacity than a line with shorter headways. As headways increase, capacity goes down. In commuter type operations, shorter headways during peak periods are required to meet passenger demand. **Table 3** and **Table 4** below list the proposed service headways for 2021 and 2035, respectively.

Table 3: Proposed 2021 Service Headways for Peak, Off-Peak, and Weekend Service

Monday-Saturday		Sunday	
5:00 AM - 6:00 AM	15-minute headways	—	—
6:00 AM - 9:00 AM	10-minute headways	—	—
9:00 AM - 3:30 PM	10-minute headways	10:00 AM - 3:30 PM	10-minute headways
3:30 PM - 6:30 PM	10-minute headways	3:30 PM - 6:30 PM	10-minute headways
6:30 PM - 9:00 PM	10-minute headways	6:30 AM - 10:00 PM	10-minute headways
9:00 PM - 1:00 AM	15-minute headways	—	—

Source: The timeframes identified above (5:00 AM – 6:00 AM, etc.) were extracted from the Red Line Final Definition of Alternatives and Operating Plans, Version 3, dated April 21, 2010. The identfied headways have recently been developed based on the 2020 ridership forecast (for 2021 service).

Table 4: Proposed 2035 Service Headways for Peak, Off-Peak, and Weekend Service

Monday-Saturday		Sunday	
5:00 AM - 6:00 AM	15-minute headways	—	—
6:00 AM - 9:00 AM	7-minute headways	—	—
9:00 AM - 3:30 PM	10-minute headways	10:00 AM - 3:30 PM	10-minute headways
3:30 PM - 6:30 PM	7-minute headways	3:30 PM - 6:30 PM	10-minute headways
6:30 PM - 9:00 PM	10-minute headways	6:30 PM - 10:00 PM	10-minute headways
9:00 PM - 1:00 AM	15-minute headways	—	—

Source: Red Line Final Definition of Alternatives and Operating Plans, Version 3, dated April 21, 2010. These headways were developed during the DEIS study for 2030 and are subject to change.

5.3 Cycle Time

Cycle time is the total time it takes a train to depart its initial terminal, make a round trip, and then become ready to depart again from its original terminal. Included in this calculation is the time a train dwells at each terminal during the cycle. This time is used for pre-departure activities and as recovery time.

For the purposes of this study, the cycle time was assumed to be 102 minutes, which reflects 45 minutes running time in both directions plus a minimum of 6 minutes turn/recovery time at each terminal. This represents the minimum cycle time that will be used during the development of the operating plan.

6. Simulation Methodology

The Red Line Light Rail operates through three distinctly different operating environments. Some segments of the light rail line operate on dedicated corridors that are not traversed by rubber-tired traffic. Other segments operate over separated right-of-way with occasional street crossings (e.g., along I-70), or along a dedicated surface transit guideway within existing streets and with at-grade crossings (e.g., Security Boulevard, Edmondson Avenue and Boston Street). Because of intersections and turning traffic when operating within existing roadways, light rail operation is significantly affected by the street traffic control signal system.

Computer modeling software is used by most public transit agencies and railroads when designing a new system or modifying an existing one. Because of the effect of traffic signals on the portion of the Red Line that operates within existing roadways, it was determined that the impact of traffic signal-related delays should be integrated into the standard rail simulation model to reflect realistic light rail operations through the street running segments. The hybrid approach combined a range of traffic signal delays, as determined by the VISSIM traffic simulation model, with travel time analysis performed by a traditional rail operating model.

The traditional rail software used was Rail Traffic Controller (RTC), which is a product of Berkeley Simulation Software. RTC, an investment grade analysis tool, has sophisticated algorithms that calculate accurate train performance for single or multiple trains of an operating plan on the basis of distances, vertical profile (grades), horizontal alignment (curves), civil speed restrictions, station stops, dwell times at station stops, passenger loads on the train, rolling stock/equipment performance data including acceleration and braking regimes, and various types of forces affecting train movements. It realistically simulates performance of train networks of different complexity based on the train control system (signals and control lines) and user-defined operating parameters. Besides using RTC for the purpose of determining travel times and fleet requirements, it is also used for the purpose of validating the feasibility of the operating plan, functioning of the yard and end-terminals, and overall performance of the system.

In this instance, randomized traffic signal delays over the network were first determined by the VISSIM program. VISSIM is an advanced microscopic simulation behavior-based modeling tool that can perform detailed analyses of multi-modal traffic flow. The flexible, detailed nature of VISSIM makes it valuable for assessment of interactions within complex transportation networks, including freeways, arterials, transit facilities, and bicycle and pedestrian facilities. VISSIM can model many forms of signal control related to rail and vehicle traffic interaction, including Light Rail Train (LRT) signal priority and railroad pre-emption.

The range of traffic delays determined from VISSIM was introduced as inputs to the RTC model at the location where the traffic signal was located. When the RTC simulation was run, those delays were incorporated in the LRT performance results.

7. Travel Time Study Inputs

The travel time study was based on the inputs and assumptions listed below.

7.1 Vehicle Characteristics

Performance of the Siemens 70 percent Low Floor light rail vehicle was input into the simulation model and calibrated to the acceleration and deceleration parameters described in *the Red Line Rail Vehicle Design Criteria Report, Revision 3* from February 2012. A train consisting of two cars with a total length of 200 feet was used in the simulation.

7.2 Vehicle Loading

The light rail vehicle loading assumptions for RTC were based on AW2, which is 142,318 lbs and includes weight of a vehicle plus load of one operator, 72 seated passengers and 120 standing passengers.

7.3 Station Dwell Time

Station dwells were assumed to be 15 or 20 seconds, depending on forecasted ridership. These dwell times, as shown in **Table 5** below, are also representative of informal observations of current operations on MTA's Central Light Rail Line.

Table 5: Station Dwell Times

Station Name	Dwell MM:SS
Bayview MARC	0:00
Bayview Campus	0:15
Highlandtown/Greektown	0:15
Brewers Hill/Canton Crossing	0:20
Canton	0:15
Fell's Point	0:15
Harbor East	0:15
Inner Harbor	0:20
Howard Street/University Center	0:20
Poppleton	0:15
Harlem Park	0:15
EB West Baltimore MARC Station	0:20
Rosemont	0:15
Allendale EB	0:15
Edmondson Village	0:20
I-70 Park-and-Ride	0:20
Social Securrity Administration	0:15
Security Square	0:15
CMS	0:00

7.4 Civil Speed Restrictions

The maximum speed for civil design is 55 MPH. Civil speed restrictions in the train's route, shown in the table found in **Appendix B** as "Limiting Speeds," were included in the RTC travel time simulation.

7.5 Pre-emption/Priority at Traffic Signals

At some locations along the corridor, pre-emption is being considered to reduce light rail vehicle delay and facilitate its progression through the signal system. These locations include each intersection with gates and flashers (i.e., intersections that are not fully signalized), and along Franklintown Road and Bayview Boulevard, because of the close spacing of a number of intersections at these locations. For the most part, the light rail vehicle is expected to receive priority treatment along the corridor, meaning that signal phases can be shortened or lengthened by 10 seconds to accommodate a light rail vehicle movement. Pre-emption and priority treatments for the light rail vehicle were selected based on the roadway segment and intersection conditions. It is noted that operations studies will be expanded in fiscal year (FY) 2013 to assess the impacts of the train control system on overall run times, as well as to further quantify the location and types of train control – traffic signal interfaces.

7.6 Delays at Traffic Signals

A listing of traffic signals (existing and proposed), along with specific information for each may be found in **Appendix C**. It is anticipated that this itemization will change based on the results obtained from the expanded studies that will be conducted in FY'13.

Only those traffic signals that have a stop probability of greater than 5 percent were modeled in the simulation. In other words, if the stop probability is less than or equal to 5 percent in a given direction then it is assumed that the train will not encounter a red light at that traffic signal, in that direction only.

For those traffic signals where the train may encounter a red light, RTC simulations were conducted such that the trains would stop for the amount of time that falls somewhere in the range bound by minimum and maximum values shown in **Appendix C** for each direction.

7.7 Adjacent Road Speeds

Speed data used in the models assumed that the light rail vehicle would not exceed the posted speed limit for vehicular traffic on an adjacent roadway.

7.8 Station Speed Restrictions

Station speed restrictions were not included in the RTC simulation run.

8. Results

8.1 Travel Times

The RTC train simulation with the above listed assumptions results in first to last station travel times as shown in **Table 6** below. It should be noted that the train simulation travel times include the deceleration and acceleration time related to a stop at a red traffic signal.

Table 6: Simulated Travel Times

Type of Simulation	Travel Times (mm:ss)	
	Eastbound	Westbound
Unimpeded	36:27	36:18
Non-Randomized	40:49	42:25
Randomized 1	43:19	45:17
Randomized 2	43:33	45:53
Randomized 3	44:25	45:12
Randomized 4	44:58	45:14
Randomized 5	45:19	46:33
Average of all Randomized	44:19	45:38
Every Traffic Signal	47:39	48:14

Notes: In an unimpeded simulation the train encounters no red traffic signals.

In a non-randomized simulation the train encounters all traffic signals as red and no more than 2 seconds of dwell because of each red light imposed.

Randomized simulations 1 through 5 reflect the train being made to stop randomly (based on stopping probability) and for a variable dwell (based on the range of minimum to maximum stop times) because of a red traffic signal. The average of these five randomized simulations is highlighted in red and can be assumed to be the likely travel time during normal operations.

In the “Every Traffic Signal” simulation the train is made to stop at all traffic signals for the maximum stop time. This scenario is highly unlikely to happen in normal operations.

See **Appendices D and E**, respectively, for detailed run times between each station for eastbound and westbound directions.

9. Fleet Requirements

9.1 Maximum Load Point

Service frequency and train consists are determined from ridership estimates using the maximum load point calculation. The maximum load point is that segment of the alignment that has the highest volume of passengers during peak periods. Headways and train consists are then planned to provide enough capacity (seats and standees) to carry that passenger volume.

In order to determine the maximum load point, a ridership forecast must first be performed. In this case, ridership forecasts were performed for 2020 and 2035, both of which used a 42.50 minute run time for the study. The 42.50 minutes used was derived by directly adding total traffic delay time as determined by VISSIM to the travel time generated by the RTC model that included no traffic delays. The sum travel time generated was of 41.78 minutes for eastbound and 42.50 minutes for westbound. The greater travel time of 42.50 minutes was used for establishing the ridership forecasts. As the traffic delay used is not location-specific, any compounded impact of the delay on rail vehicle performance related to location is not captured, such as the difference in acceleration if a traffic signal stop is on an uphill or downhill grade.

The ridership forecast for 2020 indicates that the maximum load point is estimated to be for eastward travel between Harlem Park and Poppleton Stations, with a volume of 1,713 passengers during the peak AM hour. For the purposes of this exercise 2020 ridership forecasts are assumed to be applicable to 2021 opening day service.

The ridership forecast for 2035 indicates that the maximum load point is estimated to be for eastward travel between Harlem Park and Poppleton Stations, with a volume of 1,777 passengers during the peak AM hour (refer to **Appendix F**).

9.2 Peak Hour Headways

Peak hour headways are determined by matching vehicle capacity to passenger demand as estimated by forecasting models. The maximum load point, as noted above, is estimated to be 1,713 passengers (year 2020) and 1,777 passengers (year 2035) travelling eastward between Harlem Park and Poppleton Stations during the AM peak hour.

To determine required headways, the required number of vehicles that must operate through the maximum load point during the peak hour is determined.

To determine the AM peak hour vehicle requirement for the maximum load point segment, the maximum load point volume (1,713 and 1,777) is divided by the assumed vehicle capacity of (145) which is 11.81 and 12.25, respectively. The quotient is rounded up from 11.81 to 12 (for year 2021) and rounded up from 12.25 to 13 (for year 2035). Twelve vehicles for 2020 and 13 for 2035 represent the number of light rail vehicles required to operate through the maximum load point segment during the AM peak hour to accommodate the forecast maximum passenger loading. This translates to a requirement of six 2-car trains each hour for

2021 and seven 2-car trains for 2035. Minimum headways required for 2021 would be 10 minutes and 9 minutes for 2035.

Based on the maximum load point calculation method, the necessary service requirement is six 2-car trains each hour in 2021 and seven 2-car trains in 2035. Six trains operating within 60 minutes require 10-minute headways. Seven trains operating within 60 minutes require 9-minute (8.6 minutes rounded up) headways. However, in order to provide more frequent service opportunities, it is planned to operate on 7-minute headways in 2035.

9.3 Vehicle Requirements

Total vehicle requirements are based on the frequency of service during the peak period, the cycle time and train consist size.

If it is desired to operate on 10-minute headways, the vehicle requirement can be determined by dividing the cycle time by the headway. Using an estimated 45-minute run time and a 6-minute terminal/recovery time at each terminal, the total cycle time would be 102 minutes. Based on 10-minute headways and 102-minute cycle times, the vehicle requirement to operate this level of service would be 11 trains (rounded up from 10.2), or 22 cars.

In order to provide more service opportunities in 2035, as is intended, it is planned to operate on 7-minute headways. Once again, the cycle time is divided by the headway to determine the number of trains required. Using the same estimated 45-minute run time and a 6-minute terminal/recovery time, the total cycle time would be 102 minutes. Based on 7-minute headways and 102-minute cycle times, the vehicle requirement to operate this level of service would be 15 trains, or 30 cars.

Both calculations include no spare vehicles to offset those unavailable because of maintenance or other reasons.

9.4 Spare Vehicles and Fleet Size

Spare vehicles are required to replace revenue vehicles during normal and unplanned maintenance. The maximum number of revenue vehicles required is 22 if operating on 10-minute headways in 2021, and 30 if operating on 7-minute headways in 2035, during the weekday AM peak periods. If a 15 percent spare ratio is applied, the total vehicle requirement would be 26 for 10-minute headway operation and 35 for 7-minute headway operation.

Tables 7 and 8 below show the impact of different travel times in conjunction with different spare ratio percentages, and the resulting impact on the total fleet requirements for both 2021 and 2035. Note that the spare requirements are rounded up to the nearest whole number. For example, a 12 percent spare ratio applied to the 22 vehicles required for 10-minute headways results in a requirement of 2.64 vehicles, which is rounded up to three.

Table 7: Total Fleet Requirements Based on 10-Minute Headways (2021)

Run Time	Recovery Time	Cycle Time	AM Peak Vehicle Requirement	12% Spare Ratio	Total	15% Spare Ratio	Total	20% Spare Ratio	Total
45	6	102	22	3	25	4	26	5	27
46	6	104	22	3	25	4	26	5	27
47	6	106	22	3	25	4	26	5	27
48	6	108	22	3	25	4	26	5	27

Table 8: Total Fleet Requirements Based on 7-Minute Headways (2035)

Run Time	Recovery Time	Cycle Time	AM Peak Vehicle Requirement	12% Spare Ratio	Total	15% Spare Ratio	Total	20% Spare Ratio	Total
45	6	102	30	4	34	5	35	6	36
46	6	104	30	4	34	5	35	6	36
47	6	106	32	4	36	5	37	7	39
48	6	108	32	4	36	5	37	7	39

The spare vehicle ratio varies from property to property based on a number of variables, but it is customarily not more than 20 percent. However, applying spare ratio percentages in a strictly linear manner may be misleading when considering a smaller fleet, which may experience disproportionally higher impacts from unexpected events than larger fleets. As an example, consider the impact of the following typical maintenance conditions:

- One car out of service daily for periodic/scheduled maintenance
- One or two cars out of service for unscheduled maintenance
- One car out of service for collision damage repair (a common occurrence in light rail operations)
- Two cars (one train) hot standby/gap train

Conservatively assuming that this typical scenario requires six spare cars, then all calculated spare ratios in **Table 7** above fall below six cars when a 22 vehicle AM requirement is considered. Nor is the assumed six car minimum requirement met under all spare ratio conditions when considering a 2035 30 vehicle AM requirement. However, it is recommended that no less than six spare cars be procured to support normal fleet operations, bringing the recommended 2021 opening day fleet size to 28 vehicles, and the recommended 2035 fleet size to 36 vehicles.

9.5 Vehicle Procurement

It is suggested that consideration be given to a two-step procurement wherein only the vehicles necessary to provide service at the 2021 Opening Day level be purchased during the initial procurement process, with the balance necessary to support 2035 service levels provided at a later date. **Table 9** below identifies the major activities associated with vehicle procurement, assuming a revenue operating date of June 2021.

Table 9: Anticpiated Vehicle Procurement Milestones

Activity	Start	Finish
Technical Specifications 90% complete and ready for industry review	—	May 2014
Industry review with final technical specifications	May 2014	November 2014
Proposal, proposal evaluation, contract award	November 2014	November 2015
NTP for vendor (2-3 years before first car is delivered)	—	December 2015
Delivery of first vehicles	—	December 2018
Commissioning of vehicles & employee training (12 – 18 months)	January 2019	June 2021
Revenue Service	—	June 2021

10. Train Operations

Detailed operating information will be developed by the Red Line GEC Team and presented in a Concept of Operations (ConOps) which will be created in FY'13. As preliminary engineering progresses during FY'13, the operations of the Red Line will be updated to include a more detailed study of the single track run times between crossovers to confirm probable operating times. In addition, operations studies will be expanded in FY'13 to assess the impacts of the train control system on overall run times, as well as to further quantify the location and types of train control – traffic signal interfaces. However, for informational purposes, some basic operating information has been included in this plan that is essentially independent of the study results.

It is anticipated that the Red Line will be operated consistent with current operating rules and procedures employed at the Central Light Rail Line. It has been requested that procedures related to Horn and Bell usage be included in this report. Below are the current Central Light Rail Line procedures for horn and bell usage.

10.1 Horn Signals

The horn must be sounded in the prescribed manner as shown below. Sounds are illustrated by using "o" for a short sound and "—" for a longer sound. Unnecessary or excessive use of the horn is prohibited.

- <u>ooooooo (Succession of short sounds)</u>: When an emergency exists, warning persons on or about the track, or approaching a train stopped on an adjacent track.
- <u>o (One short sound)</u>: Approaching highway grade crossing unless otherwise designated.
- <u>— — o — (Two long, one short, one long sound)</u>: Approaching grade or pedestrian crossing, where designated.
- <u>oo (Two short sounds)</u>: Answer to any hand signal. Before moving forward in the yard or within the yard limits.
- <u>ooo (Three short sounds)</u>: Before moving backwards.

10.2 Bell Signals

Vehicle bell shall be used:

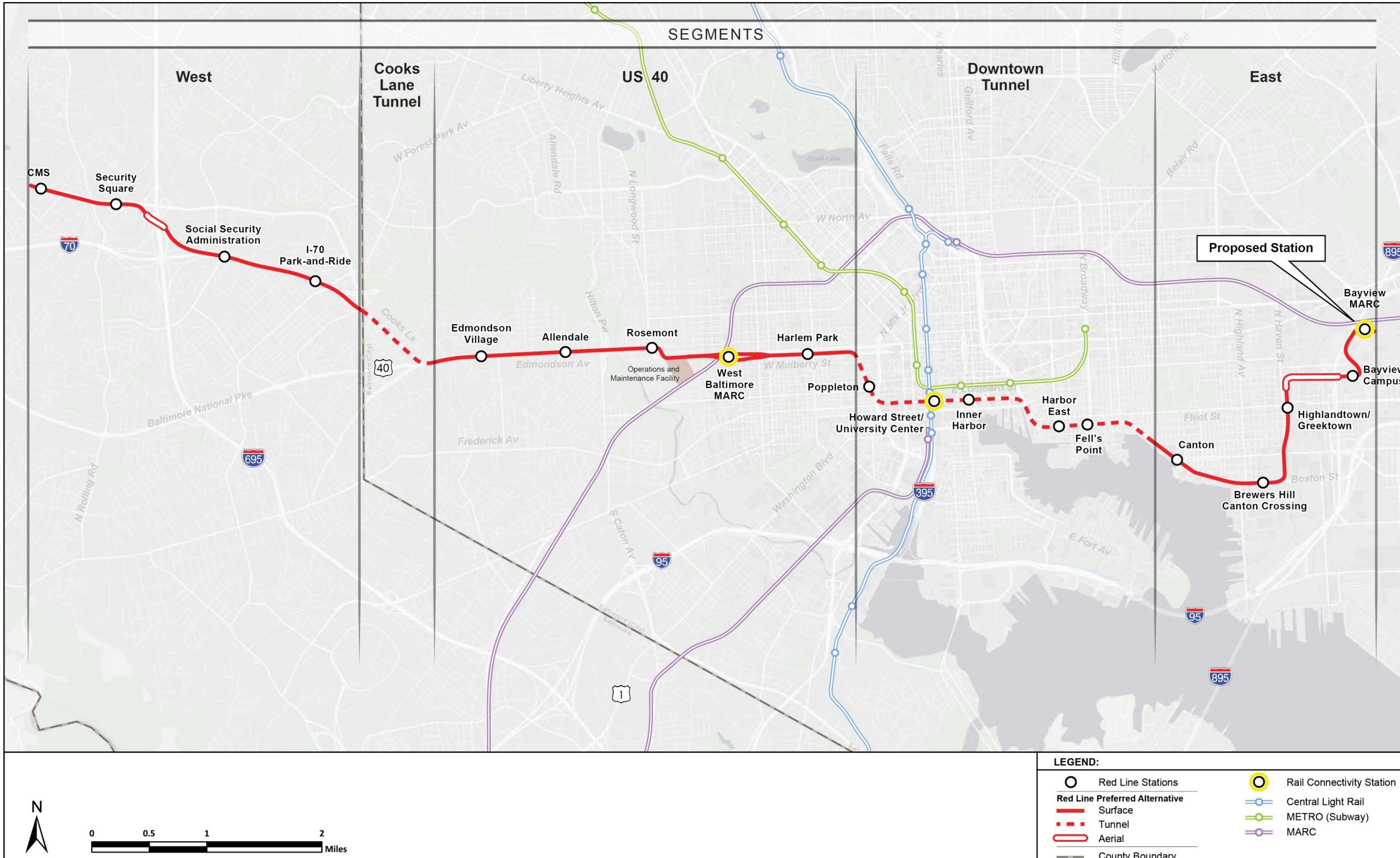
- to acknowledge a hand signal,
- when about to move in either direction,
- when passing a train standing on an adjacent track,
- when approaching and passing through stations, and making station stops,
- when approaching persons on or about the tracks; and
- at locations where vision is obscured.

In the absence of a warning bell on the lead car of a train, horn signals should be used. Light Rail control must be notified, and train must be replaced at the first opportunity.

a. Cooks Lane and Downtown Tunnel:

The Central Light Rail Line (CLRL) alignment is a surface system with no tunnel segments and therefore there are no existing CLRL rules or procedures for tunnel operations. However, consistent with current operations of the Baltimore Metro and as is typical on other properties, the light rail vehicle horn and bell will be sounded when entering and exiting the tunnel portals.

Appendix A
Red Line Preferred Alternative



Appendix A: Red Line Preferred Alternative

Appendix B
Civil Speed Restrictions

From STA.	To STA.	Distance (Feet)	Corridor Description	Design Speed (mph)				
				Limiting	Horizontal	Vertical	Intersection*	Platform
CMS to Cooks Lane Portal								
1+00	3+28	228	Horizontal	**10**	10	x	x	x
3+28	5+01	173	Platform	**30**	x	55	x	x
5+01	7+46	245	Tangent	**30**	x	x	x	x
7+46	8+46	100	Platform	**30**	x	55	x	x
8+46	11+26	280	Tangent	**30**	x	x	x	x
11+26	12+26	100	Platform	**30**	x	55	x	x
12+26	14+34	209	Tangent	**30**	x	x	x	x
14+34	15+76	141	Horizontal	**30**	30	x	30	x
15+76	18+09	234	Tangent	**30**	x	x	x	x
18+09	21+51	341	Intersection	**30**	x	55	30	x
21+51	25+66	415	Intersection	**30**	x	55	30	x
25+66	27+94	228	Horizontal	**30**	30	55	x	x
27+94	35+74	781	Horizontal	**35**	35	55	35	x
35+74	37+00	126	Tangent	**35**	x	x	x	x
37+00	39+78	278	Horizontal	**35**	35	55	35	x
39+78	42+72	294	Tangent	**35**	x	x	x	x
42+72	44+45	173	Intersection	**35**	x	55	35	x
44+45	56+22	1177	Horizontal	**30**	30	55	x	x
56+22	59+36	314	Tangent	**55**	x	x	x	x
59+36	61+86	250	Vertical	**55**	x	55	x	x
61+86	64+60	274	Tangent	**55**	x	x	x	x
64+60	69+52	492	Horizontal	**35**	35	55	x	x
69+52	77+69	817	Horizontal	**40**	40	55	x	x
77+69	86+31	862	Horizontal	**45**	45	55	x	x
86+31	92+48	617	Horizontal	**50**	50	55	x	x
92+48	98+09	561	Horizontal	**50**	50	55	x	x
98+09	100+09	200	Tangent	**55**	x	x	x	x
100+09	105+50	541	Horizontal	**50**	50	x	x	x
105+50	109+72	422	Horizontal	**45**	45	55	x	x
109+72	111+92	220	Horizontal	**45**	45	55	x	x
111+92	116+18	426	Horizontal	**45**	45	x	x	x
116+18	123+81	763	Horizontal	**55**	55	55	x	x
123+81	141+34	1753	Horizontal	**55**	55	55	x	x
141+34	143+34	200	Tangent	**55**	x	x	x	x
143+34	148+69	536	Horizontal	**40**	40	x	x	x
148+69	154+75	606	Horizontal	**45**	45	55	x	x
154+75	156+67	192	Tangent	**55**	x	x	x	x
Cooks Lane Tunnel								
156+67	163+46	679	Horizontal	**55**	55	x	x	x

From STA.	To STA.	Distance (Feet)	Corridor Description	Design Speed (mph)				
				Limiting	Horizontal	Vertical	Intersection*	Platform
163+46	166+46	300	Vertical	55	x	55	x	x
166+46	169+99	353	Horizontal	55	55	x	x	x
169+99	173+99	400	Horizontal	55	55	55	x	x
173+99	200+11	2613	Tangent	55	x	x	x	x
200+11	208+43	832	Horizontal	35	35	55	x	x
208+43	211+79	335	Tangent	55	x	x	x	x
211+79	217+35	556	Horizontal	35	35	55	x	x
Cooks Lane Portal to Downtown Portal								
217+35	227+23	989	Intersection	30	x	55	30	x
227+23	231+23	400	Intersection	30	x	x	30	x
231+23	234+31	308	Platform	30	x	55	30	x
234+31	235+76	145	Platform	30	30	x	30	x
235+76	236+31	55	Vertical	30	x	x	30	x
236+31	237+77	145	Horizontal	30	30	x	30	x
237+77	240+41	264	Intersection	30	x	x	30	x
240+41	241+67	127	Tangent	30	35	x	30	x
241+67	242+23	56	Intersection	30	x	x	30	x
242+23	244+23	200	Tangent	30	35	55	30	x
244+23	245+98	175	Vertical	30	x	x	30	x
245+98	248+98	300	Tangent	30	x	55	30	x
248+98	250+73	175	Vertical	30	x	x	30	x
250+73	252+73	200	Tangent	30	x	55	30	x
252+73	254+33	159	Vertical	30	x	x	30	x
254+33	255+16	84	Tangent	30	x	x	30	x
255+16	256+38	122	Intersection	30	30	55	30	x
256+38	257+17	79	Intersection	30	x	x	30	x
257+17	258+68	150	Tangent	30	30	x	30	x
258+68	258+80	13	Horizontal	30	x	x	30	x
258+80	260+23	143	Intersection	30	x	x	30	x
260+23	264+23	400	Tangent	30	x	55	30	x
264+23	264+30	6	Intersection	30	x	x	30	x
264+30	265+57	128	Horizontal	30	30	x	30	x
265+57	266+10	53	Horizontal	30	x	x	30	x
266+10	267+40	130	Horizontal	29	29	55	30	x
267+40	270+11	271	Intersection	30	x	55	30	x
270+11	270+79	68	Vertical	30	x	55	30	x
270+79	271+23	45	Intersection	30	x	55	30	x
271+23	273+06	183	Vertical	30	x	55	30	x
273+06	273+54	48	Platform	30	x	x	30	x

From STA.	To STA.	Distance (Feet)	Corridor Description	Design Speed (mph)				
				Limiting	Horizontal	Vertical	Intersection*	Platform
273+54	274+77	123	Intersection	30	35	x	30	x
274+77	274+94	17	Horizontal	30	x	x	30	x
274+94	276+34	141	Intersection	30	35	55	30	x
276+34	277+94	160	Horizontal	30	x	55	30	x
277+94	279+20	125	Vertical	25	25	55	30	x
279+20	279+26	6	Horizontal	30	x	55	30	x
279+26	280+51	125	Vertical	25	25	55	30	x
280+51	282+17	166	Intersection	30	x	55	30	x
282+17	282+78	61	Vertical	30	x	x	30	x
282+78	284+03	125	Intersection	30	30	x	30	x
284+03	284+81	78	Intersection	30	x	x	30	x
284+81	286+35	154	Horizontal	30	30	x	30	x
286+35	286+75	40	Horizontal	30	x	x	30	x
286+75	288+33	158	Intersection	30	x	x	30	x
288+33	289+67	134	Horizontal	30	30	55	30	x
289+67	290+03	35	Intersection	30	x	55	30	x
290+03	291+47	145	Vertical	30	30	x	30	x
291+47	295+92	444	Intersection	30	x	x	30	x
295+92	297+72	180	Tangent	30	35	55	30	x
297+72	298+78	107	Vertical	30	35	x	30	x
298+78	302+82	404	Horizontal	30	x	x	30	x
302+82	308+82	600	Tangent	30	35	55	30	x
308+82	309+00	18	Vertical	30	x	x	30	x
309+00	309+36	36	Intersection	30	x	x	30	x
309+36	312+29	293	Intersection	30	x	x	30	x
312+29	313+59	130	Platform	30	x	x	30	x
313+59	314+05	46	Intersection	10	10	55	30	x
314+05	317+29	324	Intersection	30	x	x	30	x
317+29	316+82	-47	Intersection	30	x	55	30	x
316+82	317+31	49	Tangent	30	x	x	30	x
317+31	319+51	220	Vertical	10	10	55	30	x
319+51	321+43	192	Tangent	30	x	55	30	x
321+43	326+07	464	Intersection	30	x	x	30	x
326+07	327+61	153	Vertical	30	30	x	30	x
327+61	327+93	32	Intersection	30	x	x	30	x
327+93	329+38	145	Horizontal	30	30	x	30	x
329+38	337+36	798	Tangent	30	x	x	30	x
337+36	339+86	250	Horizontal	20	30	55	30	x
339+86	341+80	194	Horizontal	30	30	x	30	x

From STA.	To STA.	Distance (Feet)	Corridor Description	Design Speed (mph)				
				Limiting	Horizontal	Vertical	Intersection*	Platform
341+80	343+97	217	Vertical	30	x	x	30	x
343+97	345+12	114	Tangent	17	17	55	30	x
345+12	347+89	277	Intersection	30	x	x	30	x
347+89	349+41	152	Tangent	17	17	55	30	x
349+41	351+61	220	Vertical	30	x	55	30	x
351+61	354+42	282	Vertical	30	x	x	30	x
354+42	356+36	194	Horizontal	22	22	55	30	x
356+36	356+38	2	Intersection	30	x	x	30	x
356+38	359+04	266	Vertical	24	24	55	30	x
359+04	360+10	106	Intersection	30	x	x	30	x
360+10	363+54	344	Horizontal	30	31	x	30	x
363+54	375+11	1156	Tangent	35	38	55	50	x
375+11	376+82	171	Platform	35	35	x	50	x
376+82	377+15	33	Vertical	50	x	x	50	x
377+15	379+69	254	Horizontal	35	35	55	50	x
379+69	380+96	127	Vertical	50	x	x	50	x
380+96	381+96	100	Tangent	40	44	55	50	x
381+96	382+66	70	Intersection	44	44	x	50	x
382+66	386+10	344	Tangent	50	x	x	50	x
386+10	388+60	250	Horizontal	35	x	55	50	x
388+60	388+69	9	Vertical	44	44	x	50	x
388+69	390+71	202	Horizontal	35	44	55	50	x
390+71	391+23	52	Horizontal	44	44	x	50	x
391+23	396+72	549	Tangent	50	x	x	50	x
WB West Baltimore MARC split								
6000+00	6002+86	286	Horizontal	35	35	x	x	x
6002+86	6004+79	193	Horizontal	30	30	55	x	x
6004+79	6012+00	721	Platform	35	x	55	x	x
6012+00	6014+31	231	Intersection	35	x	x	35	x
6014+31	6017+76	345	Horizontal	35	35	x	x	x
6017+76	6017+82	6	Intersection	35	x	x	35	x
6017+82	6018+32	50	Intersection	35	x	x	35	x
6018+32	6019+84	152	Tangent	35	x	x	x	x
6019+84	6032+81	1297	Horizontal	35	35	55	x	x
Downtown Tunnel								
396+72	403+06	634	Vertical	55	x	55	x	x
403+06	407+50	443	Horizontal	20	20	55	x	x
407+50	421+38	1388	Tangent	55	x	x	x	x
421+38	422+80	143	Vertical	55	x	55	x	x

From STA.	To STA.	Distance (Feet)	Corridor Description	Design Speed (mph)				
				Limiting	Horizontal	Vertical	Intersection*	Platform
422+80	424+80	200	Tangent	55	x	x	x	x
424+80	435+58	1077	Horizontal	30	30	55	x	x
435+58	448+21	1264	Tangent	55	x	x	x	x
448+21	450+65	243	Vertical	55	x	55	x	x
450+65	452+65	200	Tangent	55	x	x	x	x
452+65	455+54	289	Vertical	55	x	55	x	x
455+54	469+78	1425	Tangent	55	x	x	x	x
469+78	472+70	292	Vertical	55	x	55	x	x
472+70	474+70	200	Tangent	55	x	x	x	x
474+70	479+23	453	Vertical	55	x	55	x	x
479+23	484+43	520	Horizontal	25	25	55	x	x
484+43	491+08	665	Tangent	55	x	x	x	x
491+08	500+37	929	Horizontal	35	35	55	x	x
500+37	504+99	461	Tangent	55	x	x	x	x
504+99	514+68	969	Horizontal	35	35	55	x	x
514+68	516+68	200	Vertical	55	x	55	x	x
516+68	519+32	264	Vertical	55	x	55	x	x
519+32	528+37	905	Tangent	55	x	x	x	x
528+37	530+88	251	Vertical	55	x	55	x	x
530+88	532+88	200	Tangent	55	x	x	x	x
532+88	548+73	1585	Tangent	55	x	x	x	x
548+73	555+10	637	Horizontal	35	35	x	x	x
555+10	559+27	417	Vertical	55	x	55	x	x
559+27	568+08	881	Tangent	55	x	x	x	x
568+08	570+53	245	Horizontal	20	20	55	x	x
570+53	572+08	155	Vertical	55	x	55	x	x
572+08	573+27	119	Tangent	55	x	x	x	x
573+27	575+44	217	Tangent	55	x	x	x	x
Downtown Tunnel Portal to Bayview								
575+44	575+59	15	Tangent	55	x	x	x	x
575+59	576+59	100	Platform	30	x	55	x	x
576+59	577+72	113	Tangent	30	x	x	x	x
577+72	577+93	21	Platform	30	x	x	35	x
577+93	578+72	79	Horizontal	22	22	x	35	x
578+72	579+08	36	Horizontal	22	22	x	x	x
579+08	579+12	4	Tangent	30	x	x	x	x
579+12	581+12	200	Tangent	30	x	x	x	x
581+12	581+19	6	Tangent	30	x	x	x	x
581+19	582+29	111	Horizontal	25	25	x	x	x

From STA.	To STA.	Distance (Feet)	Corridor Description	Design Speed (mph)				
				Limiting	Horizontal	Vertical	Intersection*	Platform
582+29	582+64	35	Horizontal	25	25	55	x	x
582+64	583+00	36	Horizontal	25	25	55	35	x
583+00	583+14	14	Platform	30	x	55	35	x
583+14	583+59	45	Platform	30	x	55	x	x
583+59	586+62	303	Tangent	30	x	x	x	x
586+62	587+62	100	Platform	30	x	55	x	x
587+62	588+15	53	Tangent	30	x	x	x	x
588+15	588+68	54	Horizontal	28	28	x	x	x
588+68	589+39	71	Horizontal	28	28	x	35	x
589+39	590+65	126	Horizontal	28	28	x	x	x
590+65	591+27	62	Tangent	30	x	x	x	x
591+27	592+42	115	Platform	30	x	55	x	x
592+42	593+24	82	Tangent	30	x	x	x	x
593+24	593+34	10	Platform	30	x	55	x	x
593+34	593+80	46	Platform	30	x	55	35	x
593+80	594+64	84	Platform	30	x	55	x	x
594+64	597+42	278	Tangent	30	x	x	x	x
597+42	597+92	50	Platform	30	x	x	35	x
597+92	605+71	779	Tangent	30	x	x	x	x
605+71	606+08	37	Horizontal	30	30	x	x	x
606+08	606+38	29	Horizontal	30	30	x	35	x
606+38	606+58	21	Horizontal	30	30	55	35	x
606+58	606+88	29	Horizontal	30	30	55	x	x
606+88	610+63	375	Horizontal	30	30	x	x	x
610+63	611+08	45	Horizontal	30	30	x	35	x
611+08	611+24	16	Horizontal	30	30	x	x	x
611+24	612+04	80	Horizontal	30	30	55	x	x
612+04	613+56	152	Horizontal	30	30	x	x	x
613+56	615+74	218	Horizontal	30	30	x	x	x
615+74	617+91	216	Horizontal	30	30	55	x	x
617+91	618+00	10	Horizontal	30	30	55	x	x
618+00	618+70	70	Intersection	30	x	55	30	x
618+70	618+84	14	Horizontal	20	20	55	30	x
618+84	619+10	26	Horizontal	20	20	55	30	x
619+10	619+41	31	Horizontal	20	20	55	x	x
619+41	619+98	58	Horizontal	20	20	x	x	x
619+98	621+13	115	Tangent	30	x	x	x	x
621+13	623+13	200	Tangent	30	x	x	x	x
623+13	623+80	67	Tangent	30	x	x	x	x

From STA.	To STA.	Distance (Feet)	Corridor Description	Design Speed (mph)				
				Limiting	Horizontal	Vertical	Intersection*	Platform
623+80	624+55	75	Intersection	30	x	x	30	x
624+55	624+62	7	Intersection	30	x	55	30	x
624+62	626+55	193	Intersection	30	x	55	30	x
626+55	626+65	10	Tangent	30	x	x	x	x
626+65	628+02	137	Horizontal	20	20	x	x	x
628+02	628+38	36	Horizontal	20	20	55	x	x
628+38	629+12	74	Platform	30	x	55	x	x
629+12	629+52	40	Intersection	30	x	55	30	x
629+52	630+29	76	Intersection	30	x	x	30	x
630+29	630+44	15	Horizontal	19	19	x	30	x
630+44	631+83	140	Horizontal	19	19	x	x	x
631+83	633+33	150	Horizontal	19	19	55	x	x
633+33	633+98	65	Horizontal	19	19	x	x	x
633+98	639+65	567	Tangent	55	x	x	x	x
639+65	641+15	150	Vertical	55	x	55	x	x
641+15	643+37	222	Tangent	55	x	x	x	x
643+37	647+80	443	Horizontal	40	40	x	x	x
647+80	650+28	248	Tangent	55	x	x	x	x
650+28	651+42	114	Vertical	55	x	55	x	x
651+42	653+28	186	Horizontal	45	45	55	x	x
653+28	659+49	620	Horizontal	45	45	x	x	x
659+49	659+76	27	Tangent	55	x	x	x	x
659+76	661+76	200	Vertical	55	x	55	x	x
661+76	663+02	126	Tangent	55	x	x	x	x
663+02	665+02	200	Tangent	55	x	x	x	x
665+02	667+70	268	Tangent	55	x	x	x	x
667+70	668+05	35	Horizontal	45	45	x	x	x
668+05	669+81	176	Horizontal	45	45	55	x	x
669+81	670+05	24	Vertical	55	x	55	x	x
670+05	670+55	50	Tangent	55	x	x	x	x
670+55	671+60	105	Vertical	55	x	55	x	x
671+60	673+54	194	Horizontal	45	45	55	x	x
673+54	673+65	12	Vertical	55	x	55	x	x
673+65	675+27	161	Tangent	55	x	x	x	x
675+27	678+20	293	Horizontal	24	24	x	x	x
678+20	681+07	287	Horizontal	24	24	55	x	x
681+07	683+20	213	Vertical	55	x	55	x	x
683+20	698+92	1573	Tangent	55	x	x	x	x
698+92	700+92	200	Vertical	55	x	55	x	x

From	To	Distance	Corridor	Design Speed (mph)				
STA.	STA.	(Feet)	Description	Limiting	Horizontal	Vertical	Intersection*	Platform
700+92	702+12	120	Tangent	55	x	x	x	x
702+12	702+18	6	Platform	25	35	x	x	x
702+18	703+18	100	Platform	25	35	55	x	x
703+18	703+72	55	Platform	25	35	x	x	x
703+72	704+41	68	Tangent	25	x	x	x	x
704+41	705+41	100	Platform	25	x	55	x	x
705+41	707+38	198	Tangent	25	x	x	x	x
707+38	709+38	200	Tangent	25	x	x	x	x
709+38	710+04	66	Tangent	25	x	x	x	x
710+04	710+05	0	Platform	25	x	55	x	x
710+05	711+04	100	Horizontal	13	13	55	x	x
711+04	711+97	92	Horizontal	13	13	x	x	x
711+97	712+76	80	Horizontal	13	13	55	x	x
712+76	712+97	20	Platform	25	x	55	x	x
712+97	713+44	47	Tangent	25	x	x	x	x
713+44	713+66	22	Platform	25	x	x	35	x
713+66	713+74	8	Horizontal	18	18	x	35	x
713+74	714+33	59	Horizontal	18	18	x	x	x
714+33	715+33	100	Horizontal	18	18	55	x	x
715+33	715+93	60	Horizontal	18	18	x	x	x
715+93	715+60	-32	Tangent	25	x	x	x	x
715+60	716+04	44	Platform	25	x	x	35	x
716+04	716+44	39	Tangent	25	x	x	x	x
716+44	717+44	100	Platform	25	x	55	x	x
717+44	718+45	101	Tangent	25	x	x	x	x
718+45	719+08	63	Platform	25	x	55	x	x
719+08	719+45	37	Platform	25	x	55	35	x
719+45	719+78	33	Platform	25	x	x	35	x
719+78	720+46	68	Tangent	55	x	x	x	x
720+46	720+61	15	Vertical	55	x	55	x	x
720+61	721+46	85	Horizontal	30	30	55	x	x
721+46	727+05	558	Horizontal	30	30	x	x	x
727+05	728+05	100	Horizontal	30	30	55	x	x
728+05	729+14	109	Horizontal	30	30	x	x	x
729+14	734+54	540	Tangent	55	x	x	x	x
734+54	738+57	404	Horizontal	20	20	x	x	x
738+57	739+17	60	Tangent	55	x	x	x	x
739+17	741+17	200	Tangent	55	x	x	x	x
741+17	741+84	67	Tangent	55	x	x	x	x

From STA.	To STA.	Distance (Feet)	Corridor Description	Design Speed (mph)				
				Limiting	Horizontal	Vertical	Intersection*	Platform
741+84	742+18	34	Horizontal	**15**	15	x	x	x
742+18	743+18	100	Horizontal	**15**	15	55	x	x
743+18	743+86	68	Horizontal	**15**	15	x	x	x
743+86	745+51	165	Tangent	**55**	x	x	x	x

Notes: Max speed through intersection = 35 mph.
Prioritization to be provided, but not pre-emption.
** Max vehicle speed = 55 mph
*** Crossover locations ignored

Appendix C
Traffic Signals

	Location	Existing Control	Control with Red Line	Intersection / Track Stationing	Comments	Stop Time (s)				Stop Probability	
						Min		Max			
						EB	WB	EB	WB	EB	WB
West Segment											
CMS Platform				393+34							
1	Greengage Road at Security Boulevard	Stop	Traffic Signal	384+30	Could be unsignalized with gates	0	0	24	21	37%	58%
2	Brookdale Road at Security Boulevard	Stop	Traffic Signal	378+00	Could be unsignalized with gates	0	0	2	3	4%	25%
3	Kennicott Road/Paner a Bread	Stop	Traffic Signal	375+15	Could be unsignalized with gates	0	0	0	0	0%	0%
4	Rolling Road at Security Boulevard	Traffic Signal	Traffic Signal	369+70		0	0	22	6	18%	20%
5	Lord Baltimore Drive at Security Boulevard	Traffic Signal	Traffic Signal	361+80		0	0	19	33	42%	43%
Security Square Platform				358+10							
6	Belmont Avenue at Security Boulevard	Traffic Signal	Traffic Signal	355+75		0	0	58	18	13%	46%
SSA Platform				300+00							
7	New I-70 / SSA Access Road	—	Traffic Signal	278+15							
8	Parallel Drive / Park-and-Ride Access	—	Traffic Signal	258+50	No LRT Crossing						
9	Rail Crossing / Park-and-Ride Access	—	Flashers	258+50	No gates						
I-70 Park-and-Ride Platform				256+68							

	Location	Existing Control	Control with Red Line	Intersection / Track Stationing	Comments	Stop Time (s)				Stop Probability	
						Min		Max			
						EB	WB	EB	WB	EB	WB
10	Parallel Drive / Ingleside Avenue	Traffic Signal	Traffic Signal	248+30	No LRT Crossing						
11	Ingleside Avenue / Security Boulevard	Traffic Signal	Traffic Signal	245+65	No LRT Crossing						
Cooks Lane Tunnel Segment											
US 40 Segment											
1	Upland Parkway / Winans Way at Edmondson Avenue	Traffic Signal	Traffic Signal	WBR 182+82.89 TO WBR 181+95.12		0	0	0	0	0%	0%
2	Glen Allen Drive at Edmondson Avenue	Traffic Signal	None	WBR 179+00.14 TO WBR 178+00.90	Signal to be removed	0	0	0	0	0%	0%
3	Swann Avenue at Edmondson Avenue	Traffic Signal	Traffic Signal	WBR 169+85.10 to WBR 168+55.55		0	0	23	10	31%	18%
Edmondson Village Platform											
4	Edmondson Village station platform access	—	Pedestrian Signal	WBR 162+69.31 TO WBR 162+50.31		0	0	0	0	0%	0%
5	Athol Avenue at Edmondson Avenue	Traffic Signal	Traffic Signal	WBR 157+12.01 TO WBR 156+25.02		0	0	27	14	29%	29%
6	Wildwood Parkway at Edmondson Avenue	Traffic Signal	Traffic Signal	WBR 141+63.49 TO WBR 140+70.28		0	0	11	17	42%	25%
7	Louden Avenue at Edmondson Avenue	Stop	Traffic Signal	WBR 137+83.33 TO WBR 137+08.55		0	0	1	3	2%	5%

	Location	Existing Control	Control with Red Line	Intersection / Track Stationing	Comments	Stop Time (s)				Stop Probability	
						Min		Max			
						EB	WB	EB	WB	EB	WB
8	Mt Holly Street at Edmondson Avenue	Traffic Signal	Pedestrian Signal	WBR 129+32.86 TO WBR 129+13.86		0	0	11	9	4%	3%
WB Allendale Platform (on Edmondson)											
9	Allendale Street at Edmondson Avenue	Traffic Signal	Traffic Signal	WBR 125+84.82 TO WBR 125+07.27		0	0	6	2	2%	18%
EB Allendale Platform (on Edmondson)											
10	Edgewood Street at Edmondson Avenue	Traffic Signal	Pedestrian Signal	WBR 117+35.62 TO WBR 116+16.61		0	0	15	19	45%	33%
11	Denison Street at Edmondson Avenue	Stop	Traffic Signal	WBR 113+76.26 TO WBR 113+10.84		0	0	13	9	8%	23%
12	Hilton Street at Edmondson Avenue	Traffic Signal	Traffic Signal	WBR 109+90.39 TO WBR 109+16.42		0	0	16	17	30%	25%
13	Edmondson Avenue at Franklin Street	Traffic Signal	Traffic Signal	WBR 89+99.15 TO WBR 88+89.39		0	0	0	0	0%	0%
14	Poplar Grove Street at Edmondson Avenue	Traffic Signal	Traffic Signal	WBR 87+73.85 TO WBR 86+91.66		0	0	0	0	0%	9%
Rosemont Platform											
15	Edmondson Avenue at Franklintown Road	Traffic Signal	Traffic Signal	WBR 83+61.95 TO WBR 81+90.30		0	0	8	6	9%	11%
16	Franklintown Road and Franklin Street	Traffic Signal	Traffic Signal	WBR 78+35.86 TO WBR 76+00.00		0	0	12	14	9%	44%

	Location	Existing Control	Control with Red Line	Intersection / Track Stationing	Comments	Stop Time (s)				Stop Probability	
						Min		Max			
						EB	WB	EB	WB	EB	WB
17	Franklin Street at west track connector to Calverton Yard (EB lanes only)	—	Flashers & Gates	EBL 75+50.12 TO EBL 74+87.54							
18	Franklin Street at east track connector to Calverton Yard (EB lanes only)	---	Flashers & Gates	EBL 70+85.25 TO EBL 68+85.49							
19	Evergreen Avenue at Franklin Street	Stop	Pedestrian Signal	WBR 68+81.27 TO WBR 68+62.27		0	0	17	18	13%	29%
20	Warwick Avenue at Franklin Street	Traffic Signal	Traffic Signal	WBR 60+62.27 TO WBR 59+95.54		0	0	12	17	33%	13%
EB and WB West Baltimore MARC Platforms											
21	Smallwood Street at Mulberry Street (EB track)	Stop	Traffic Signal	EBL 47+87.22 TO EBL 47+31.60		0		15		11%	
22	Smallwood Street at Franklin Street (WB track)	Stop	Traffic Signal	WBR 47+90.11 TO WBR 47+40.88			0		11		11%
23	Pulaski Street at Mulberry Street (EB track)	Traffic Signal	Traffic Signal	EBL 43+95.22 TO EBL 43+31.49		0		0		0%	
24	Pulaski Street at Franklin Street (WB track)	Traffic Signal	Traffic Signal	WBR 43+94.28 TO WBR 43+28.27			0		13		33%

	Location	Existing Control	Control with Red Line	Intersection / Track Stationing	Comments	Stop Time (s)				Stop Probability	
						Min		Max			
						EB	WB	EB	WB	EB	WB
25	Payson Street at Mulberry Street (EB track)	Stop	Traffic Signal	EBL 39+83.17 TO WBL 39+31.77		0		18		11%	
25	Payson Street at Franklin Street (WB track)	Stop	Traffic Signal	WBR 39+98.10 TO WBR 39+31.19			0		17		38%
Harlem Park Platform											
Downtown Tunnel Segment											
Poppleton Station											
Howard Street /University Center Station											
Inner Harbor Station											
Harbor East Station											
Fell's Point Station											
East Segment											
1	Montford/ Hudson at Boston Street	Traffic Signal	Traffic Signal	172+45							
2	Safeway driveway at Boston Street	Stop	Traffic Signal	183+35		0	0	18	32	25%	22%
Canton Platform											
3	Lakewood Avenue at Boston Street	Traffic Signal	Traffic Signal	188+60		0	0	17	0	31%	0%
4	Kenwood Avenue at Boston Street	Stop	Traffic Signal	194+15		0	0	14	11	2%	2%
5	Linwood Avenue at Boston Street	Traffic Signal	Traffic Signal	198+75		0	0	14	5	2%	9%
6	Potomac Avenue at Boston Street	Stop	Pedestrian Signal	203+00	S. Potomac will be Right Out only	0	0	0	0	0%	0%

	Location	Existing Control	Control with Red Line	Intersection / Track Stationing	Comments	Stop Time (s)				Stop Probability	
						Min		Max			
						EB	WB	EB	WB	EB	WB
7	Ellwood Street at Boston Street	Traffic Signal	Stop	207+15	Signal to be removed - Ellwood will be Right Out only						
8	East Avenue at Boston Street	Stop	Traffic Signal	211+50		0	0	0	1	0%	2%
9	Clinton Street at Boston Street	Traffic Signal	Traffic Signal	216+10		0	0	13	15	24%	37%
10	Conkling Street at Boston Street	Traffic Signal	Traffic Signal	224+00		0	0	12	20	29%	48%
Brewers Hill/Canton Crossing Platform											
11	Eaton Street at Boston Street	---	Traffic Signal	229+35		0	0	46	6	20%	18%
12	Relocated Boston Street at Boh'donnell Connector	---	Traffic Signal	235+10		0	0	38	56	73%	53%
13	Haven Street south of Dillon Street	None	Flashers & Gates	250+85	LRT grade crossing on Haven St.						
Highlandtown/Greektown Platform											
14	Cassell Drive Crossing	---	Flashers & Gates	306+75							
Bayview Campus Platform											
15	Bayview Boulevard at Alpha Commons Transitway	None	Flashers & Gates	316+00		0	0	0	0	0%	0%
16	Nathan Shock Drive at Bayview Boulevard	None	Flashers & Gates	318+05		0	0	0	0	0%	0%

	Location	Existing Control	Control with Red Line	Intersection / Track Stationing	Comments	Stop Time (s)				Stop Probability	
						Min		Max			
						EB	WB	EB	WB	EB	WB
17	NIH driveway/ Cassell Drive at Bayview Boulevard	None	Traffic Signal	320+80		0	0	0	0	0%	0%
18	Lombard Street at Bayview Boulevard	Traffic Signal	Traffic Signal	324+35		0	0	0	0	0%	0%
Bayview MARC Platform											

Appendix D

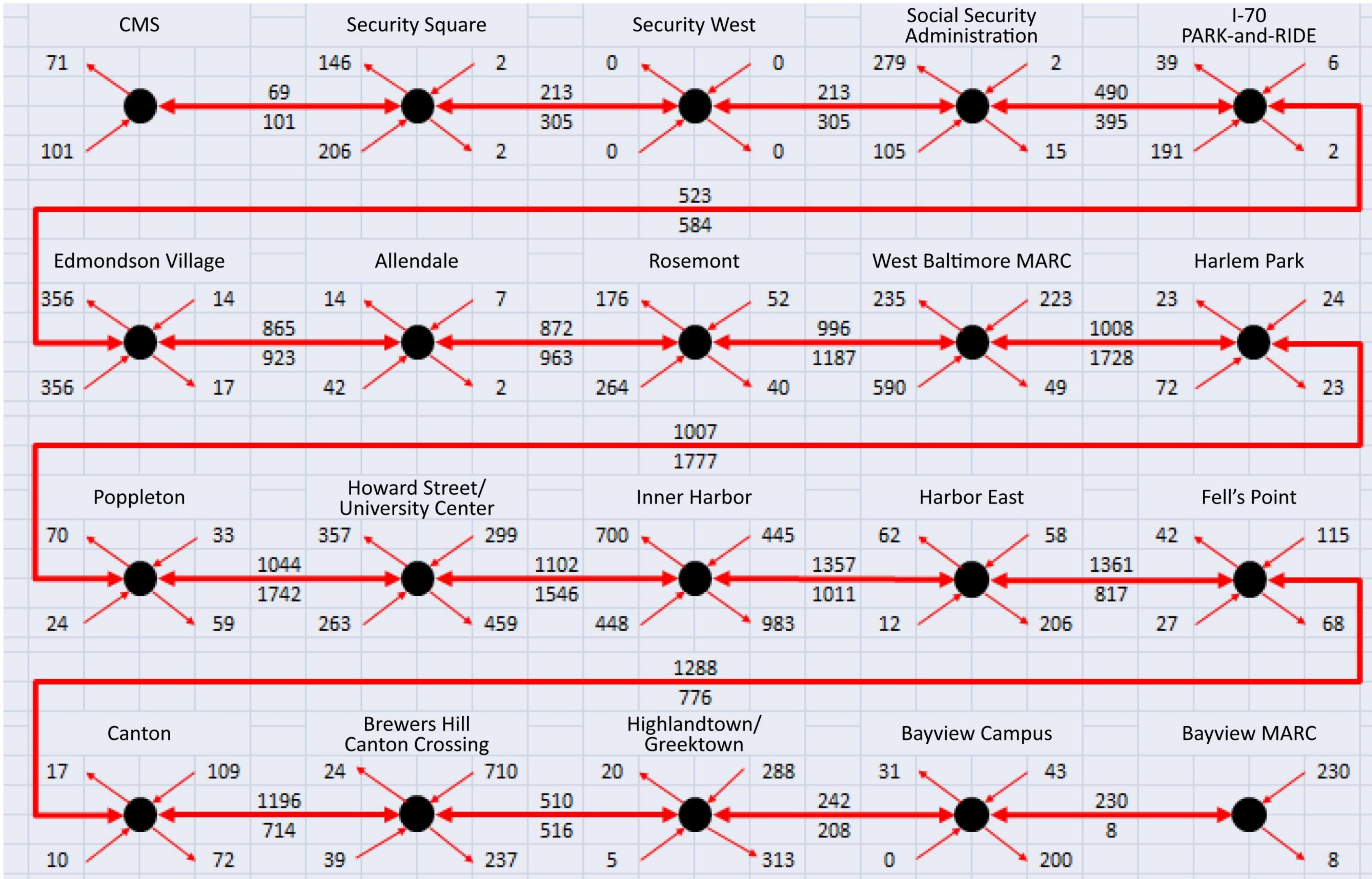
Detailed Travel Times – Eastbound

Location	Non Randomized Run (Base Line)			Randomization run 1			Randomization run 2			Randomization run 3			Randomization run 4			Randomization run 5			Non Randomized max value run		
	Head-end	Head-end		Head-end	Head-end		Head-end	Head-end		Head-end	Head-end		Head-end	Head-end		Head-end	Head-end		Head-end	Head-end	
	Arrival	Departure	Dwell	Arrival	Departure	Dwell	Arrival	Departure	Dwell	Arrival	Departure	Dwell	Arrival	Departure	Dwell	Arrival	Departure	Dwell	Arrival	Departure	Dwell
	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS
CMS		8:00:00			8:00:00			8:00:00			8:00:00			8:00:00			8:00:00			8:00:00	
Greenage Rd TS	8:00:30	8:00:32	0:02	8:00:30	8:00:33	0:03	8:00:30	8:00:34	0:04	8:00:30	8:00:45	0:15	8:00:30	8:00:53	0:23	8:00:30	8:00:46	0:16	8:00:30	8:00:54	0:24
Rolling Rd TS	8:01:20	8:01:22	0:02	8:01:21	8:01:27	0:06	8:01:22	8:01:31	0:09	8:01:33	8:01:44	0:11	8:01:41	8:01:54	0:13	8:01:34	8:01:55	0:21	8:01:42	8:02:04	0:22
Lord Balt Dr TS	8:01:54	8:01:56	0:02	8:01:59	8:02:14	0:15	8:02:03	8:02:11	0:08	8:02:16	8:02:34	0:18	8:02:26	8:02:32	0:06	8:02:27	8:02:39	0:12	8:02:36	8:02:55	0:19
Security Mall Pl	8:02:16	8:02:31	0:15	8:02:34	8:02:49	0:15	8:02:31	8:02:46	0:15	8:02:54	8:03:09	0:15	8:02:52	8:03:07	0:15	8:02:59	8:03:14	0:15	8:03:15	8:03:30	0:15
Belmont Av TS	8:02:46	8:02:48	0:02	8:03:04	8:03:18	0:14	8:03:01	8:03:27	0:26	8:03:24	8:03:30	0:06	8:03:22	8:04:12	0:50	8:03:29	8:04:16	0:47	8:03:45	8:04:43	0:58
SSA Pl	8:04:52	8:05:07	0:15	8:05:22	8:05:37	0:15	8:05:31	8:05:46	0:15	8:05:34	8:05:49	0:15	8:06:16	8:06:31	0:15	8:06:20	8:06:35	0:15	8:06:47	8:07:02	0:15
I-70 Park-and-Ride	8:06:34	8:06:54	0:20	8:07:04	8:07:24	0:20	8:07:13	8:07:33	0:20	8:07:16	8:07:36	0:20	8:07:58	8:08:18	0:20	8:08:02	8:08:22	0:20	8:08:29	8:08:49	0:20
Swann Ave TS	8:09:23	8:09:25	0:02	8:09:53	8:09:58	0:05	8:10:02	8:10:10	0:08	8:10:05	8:10:28	0:23	8:10:47	8:11:08	0:21	8:10:51	8:11:05	0:14	8:11:18	8:11:41	0:23
Edmondson Village	8:09:56	8:10:16	0:20	8:10:29	8:10:49	0:20	8:10:41	8:11:01	0:20	8:10:59	8:11:19	0:20	8:11:39	8:11:59	0:20	8:11:36	8:11:56	0:20	8:12:12	8:12:32	0:20
Athol Ave TS	8:10:49	8:10:51	0:02	8:11:22	8:11:27	0:05	8:11:34	8:11:42	0:08	8:11:52	8:12:12	0:20	8:12:32	8:12:59	0:27	8:12:29	8:12:53	0:24	8:13:05	8:13:32	0:27
Wildwood Pkwy TS	8:11:37	8:11:39	0:02	8:12:13	8:12:18	0:05	8:12:28	8:12:37	0:09	8:12:58	8:13:05	0:07	8:13:45	8:13:56	0:11	8:13:39	8:13:50	0:11	8:14:18	8:14:29	0:11
Allendale EB Pl	8:12:26	8:12:41	0:15	8:13:05	8:13:20	0:15	8:13:24	8:13:39	0:15	8:13:52	8:14:07	0:15	8:14:43	8:14:58	0:15	8:14:37	8:14:52	0:15	8:15:16	8:15:31	0:15
Edgewood Str TS	8:13:15	8:13:17	0:02	8:13:54	8:14:06	0:12	8:14:13	8:14:21	0:08	8:14:41	8:14:50	0:09	8:15:32	8:15:35	0:03	8:15:26	8:15:29	0:03	8:16:05	8:16:20	0:15
Denison Str TS	8:13:35	8:13:37	0:02	8:14:24	8:14:36	0:12	8:14:39	8:14:51	0:12	8:15:08	8:15:13	0:05	8:15:53	8:15:59	0:06	8:15:47	8:15:58	0:11	8:16:38	8:16:51	0:13
Hilton St TS	8:13:55	8:13:57	0:02	8:14:54	8:14:57	0:03	8:15:09	8:15:14	0:05	8:15:31	8:15:39	0:08	8:16:17	8:16:31	0:14	8:16:16	8:16:31	0:15	8:17:09	8:17:25	0:16
Rosemont Pl	8:14:57	8:15:12	0:15	8:15:57	8:16:12	0:15	8:16:14	8:16:29	0:15	8:16:39	8:16:54	0:15	8:17:31	8:17:46	0:15	8:17:31	8:17:46	0:15	8:18:25	8:18:40	0:15
Edmondson Ave TS	8:15:47	8:15:49	0:02	8:16:47	8:16:55	0:08	8:17:04	8:17:12	0:08	8:17:29	8:17:33	0:04	8:18:21	8:18:28	0:07	8:18:21	8:18:25	0:04	8:19:15	8:19:23	0:08
Franklintown Rd TS	8:16:28	8:16:30	0:02	8:17:34	8:17:46	0:12	8:17:51	8:18:02	0:11	8:18:12	8:18:22	0:10	8:19:07	8:19:14	0:07	8:19:04	8:19:10	0:06	8:20:02	8:20:14	0:12
Evergreen Av TS	8:17:03	8:17:05	0:02	8:18:19	8:18:29	0:10	8:18:35	8:18:52	0:17	8:18:55	8:19:08	0:13	8:19:47	8:19:55	0:08	8:19:43	8:20:00	0:17	8:20:47	8:21:04	0:17
Warwick Ave TS	8:17:37	8:17:39	0:02	8:19:01	8:19:04	0:03	8:19:24	8:19:28	0:04	8:19:40	8:19:43	0:03	8:20:27	8:20:38	0:11	8:20:32	8:20:36	0:04	8:21:36	8:21:48	0:12
EB Marc Sta	8:18:18	8:18:38	0:20	8:19:43	8:20:03	0:20	8:20:07	8:20:27	0:20	8:20:22	8:20:42	0:20	8:21:17	8:21:37	0:20	8:21:15	8:21:35	0:20	8:22:27	8:22:47	0:20
Smallwood St TS	8:19:04	8:19:06	0:02	8:20:29	8:20:32	0:03	8:20:53	8:20:58	0:05	8:21:08	8:21:15	0:07	8:22:03	8:22:15	0:12	8:22:01	8:22:15	0:14	8:23:13	8:23:28	0:15
Payson St TS	8:19:42	8:19:44	0:02	8:21:08	8:21:26	0:18	8:21:34	8:21:51	0:17	8:21:51	8:22:04	0:13	8:22:51	8:22:55	0:04	8:22:51	8:22:54	0:03	8:24:04	8:24:22	0:18
Harlem Park Sta	8:20:52	8:21:07	0:15	8:22:34	8:22:49	0:15	8:22:59	8:23:14	0:15	8:23:12	8:23:27	0:15	8:24:03	8:24:18	0:15	8:24:02	8:24:17	0:15	8:25:30	8:25:45	0:15
Poppleton Sta	8:22:50	8:23:05	0:15	8:24:32	8:24:47	0:15	8:24:57	8:25:12	0:15	8:25:10	8:25:25	0:15	8:26:01	8:26:16	0:15	8:26:00	8:26:15	0:15	8:27:28	8:27:43	0:15
Howard St/Univ St	8:24:15	8:24:35	0:20	8:25:57	8:26:17	0:20	8:26:22	8:26:42	0:20	8:26:35	8:26:55	0:20	8:27:26	8:27:46	0:20	8:27:25	8:27:45	0:20	8:28:53	8:29:13	0:20
Charles Center S	8:25:26	8:25:46	0:20	8:27:08	8:27:28	0:20	8:27:33	8:27:53	0:20	8:27:46	8:28:06	0:20	8:28:37	8:28:57	0:20	8:28:36	8:28:56	0:20	8:30:04	8:30:24	0:20
Inner Harbor East	8:27:34	8:27:49	0:15	8:29:16	8:29:31	0:15	8:29:41	8:29:56	0:15	8:29:54	8:30:09	0:15	8:30:45	8:31:00	0:15	8:30:44	8:30:59	0:15	8:32:12	8:32:27	0:15
Fell's Point Sta	8:28:34	8:28:49	0:15	8:30:16	8:30:31	0:15	8:30:41	8:30:56	0:15	8:30:54	8:31:09	0:15	8:31:45	8:32:00	0:15	8:31:44	8:31:59	0:15	8:33:12	8:33:27	0:15
Canton Platform	8:30:51	8:31:06	0:15	8:32:33	8:32:48	0:15	8:32:58	8:33:13	0:15	8:33:11	8:33:26	0:15	8:34:02	8:34:17	0:15	8:34:01	8:34:16	0:15	8:35:29	8:35:44	0:15
Safeway Dr TS	8:31:21	8:31:23	0:02	8:33:03	8:33:05	0:02	8:33:28	8:33:30	0:02	8:33:41	8:33:44	0:03	8:34:32	8:34:39	0:07	8:34:31	8:34:37	0:06	8:35:59	8:36:17	0:18
Lakewood Av TS	8:31:46	8:31:48	0:02	8:33:28	8:33:34	0:06	8:33:53	8:34:03	0:10	8:34:07	8:34:21	0:14	8:35:02	8:35:05	0:03	8:35:00	8:35:12	0:12	8:36:40	8:36:57	0:17
Clinton St TS	8:33:06	8:33:08	0:02	8:34:52	8:35:04	0:12	8:35:21	8:35:30	0:09	8:35:39	8:35:50	0:11	8:36:23	8:36:30	0:07	8:36:30	8:36:39	0:09	8:38:15	8:38:28	0:13
Conkling Str TS	8:33:25	8:33:27	0:02	8:35:21	8:35:27	0:06	8:35:47	8:35:57	0:10	8:36:07	8:36:10	0:03	8:36:47	8:36:50	0:03	8:36:56	8:37:06	0:10	8:38:45	8:38:57	0:12
Canton Crossing	8:33:51	8:34:11	0:20	8:35:51	8:36:11	0:20	8:36:21	8:36:41	0:20	8:36:34	8:36:54	0:20	8:37:14	8:37:34	0:20	8:37:30	8:37:50	0:20	8:39:21	8:39:41	0:20
Eaton St TS	8:34:39	8:34:41	0:02	8:36:39	8:37:05	0:26	8:37:09	8:37:13	0:04	8:37:22	8:38:01	0:39	8:38:02	8:38:30	0:28	8:38:18	8:38:36	0:18	8:40:09	8:40:55	0:46
O'Donnell Conn TS	8:35:11	8:35:13	0:02	8:37:35	8:37:43	0:08	8:37:43	8:37:57	0:14	8:38:31	8:38:49	0:18	8:39:00	8:39:22	0:22	8:39:06	8:39:43	0:37	8:41:25	8:42:03	0:38
Highlandtown Pl	8:36:23	8:36:38	0:15	8:38:53	8:39:08	0:15	8:39:07	8:39:22	0:15	8:39:59	8:40:14	0:15	8:40:32	8:40:47	0:15	8:40:53	8:41:08	0:15	8:43:13	8:43:28	0:15
Bayview Campus P	8:38:36	8:38:51	0:15	8:41:06	8:41:21	0:15	8:41:20	8:41:35	0:15	8:42:12	8:42:27	0:15	8:42:45	8:43:00	0:15	8:43:06	8:43:21	0:15	8:45:26	8:45:41	0:15
Bayview Marc Pl	8:40:49			8:43:19		0:01	8:43:33			8:44:25			8:44:58			8:45:19			8:47:39		

Appendix E
Detailed Travel Times – Westbound

Location	Non Randomized Run (Base Line)			Randomization run 1			Randomization run 2			Randomization run 3			Randomization run 4			Randomization run 5			Non Randomized max value run		
	Head-end	Head-end		Head-end	Head-end		Head-end	Head-end		Head-end	Head-end		Head-end	Head-end		Head-end	Head-end		Head-end	Head-end	
	Arrival	Departure	Dwell	Arrival	Departure	Dwell	Arrival	Departure	Dwell	Arrival	Departure	Dwell	Arrival	Departure	Dwell	Arrival	Departure	Dwell	Arrival	Departure	Dwell
	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS	HH:MM:SS
Bayview Marc Pl		11:00:00			11:00:00			11:00:00			11:00:00			11:00:00			11:00:00			11:00:00	
Bayview Campus P	11:02:04	11:02:19	0:15	11:02:04	11:02:19	0:15	11:02:04	11:02:19	0:15	11:02:04	11:02:19	0:15	11:02:04	11:02:19	0:15	11:02:04	11:02:19	0:15	11:02:04	11:02:19	0:15
Highlandtown Pl	11:04:12	11:04:27	0:15	11:04:12	11:04:27	0:15	11:04:12	11:04:27	0:15	11:04:12	11:04:27	0:15	11:04:12	11:04:27	0:15	11:04:12	11:04:27	0:15	11:04:12	11:04:27	0:15
O'Donnell Conn TS	11:05:33	11:05:35	0:02	11:05:33	11:05:47	0:14	11:05:33	11:05:58	0:25	11:05:33	11:05:40	0:07	11:05:33	11:06:04	0:31	11:05:33	11:06:22	0:49	11:05:33	11:06:29	0:56
Eaton St TS	11:06:05	11:06:07	0:02	11:06:17	11:06:22	0:05	11:06:28	11:06:31	0:03	11:06:10	11:06:15	0:05	11:06:34	11:06:37	0:03	11:06:52	11:06:55	0:03	11:06:59	11:07:05	0:06
Canton Crossing	11:06:44	11:07:04	0:20	11:06:59	11:07:19	0:20	11:07:08	11:07:28	0:20	11:06:52	11:07:12	0:20	11:07:14	11:07:34	0:20	11:07:32	11:07:52	0:20	11:07:42	11:08:02	0:20
Conkling Str TS	11:07:17	11:07:19	0:02	11:07:32	11:07:39	0:07	11:07:41	11:07:53	0:12	11:07:25	11:07:28	0:03	11:07:47	11:08:05	0:18	11:08:05	11:08:17	0:12	11:08:15	11:08:35	0:20
Clinton St TS	11:07:38	11:07:40	0:02	11:07:58	11:08:05	0:07	11:08:12	11:08:24	0:12	11:07:47	11:07:49	0:02	11:08:24	11:08:31	0:07	11:08:36	11:08:44	0:08	11:08:54	11:09:09	0:15
Linwood Av TS	11:08:31	11:08:33	0:02	11:08:56	11:08:59	0:03	11:09:15	11:09:20	0:05	11:08:40	11:08:43	0:03	11:09:22	11:09:24	0:02	11:09:35	11:09:40	0:05	11:10:00	11:10:05	0:05
Safeway Dr TS	11:09:22	11:09:24	0:02	11:09:48	11:10:15	0:27	11:10:09	11:10:29	0:20	11:09:32	11:10:00	0:28	11:10:13	11:10:26	0:13	11:10:29	11:11:00	0:31	11:10:54	11:11:26	0:32
Canton Platform	11:09:45	11:10:00	0:15	11:10:36	11:10:51	0:15	11:10:50	11:11:05	0:15	11:10:21	11:10:36	0:15	11:10:47	11:11:02	0:15	11:11:21	11:11:36	0:15	11:11:47	11:12:02	0:15
Fell's Point Sta	11:12:00	11:12:15	0:15	11:12:51	11:13:06	0:15	11:13:05	11:13:20	0:15	11:12:36	11:12:51	0:15	11:13:02	11:13:17	0:15	11:13:36	11:13:51	0:15	11:14:02	11:14:17	0:15
Inner Harbor East	11:12:59	11:13:14	0:15	11:13:50	11:14:05	0:15	11:14:04	11:14:19	0:15	11:13:35	11:13:50	0:15	11:14:01	11:14:16	0:15	11:14:35	11:14:50	0:15	11:15:01	11:15:16	0:15
Charles Center S	11:15:02	11:15:22	0:20	11:15:53	11:16:13	0:20	11:16:07	11:16:27	0:20	11:15:38	11:15:58	0:20	11:16:04	11:16:24	0:20	11:16:38	11:16:58	0:20	11:17:04	11:17:24	0:20
Howard St/Univ St	11:16:18	11:16:38	0:20	11:17:09	11:17:29	0:20	11:17:23	11:17:43	0:20	11:16:54	11:17:14	0:20	11:17:20	11:17:40	0:20	11:17:54	11:18:14	0:20	11:18:20	11:18:40	0:20
Poppleton Sta	11:17:51	11:18:06	0:15	11:18:42	11:18:57	0:15	11:18:56	11:19:11	0:15	11:18:27	11:18:42	0:15	11:18:53	11:19:08	0:15	11:19:27	11:19:42	0:15	11:19:53	11:20:08	0:15
Harlem Park Pl	11:19:55	11:20:10	0:15	11:20:46	11:21:01	0:15	11:21:00	11:21:15	0:15	11:20:31	11:20:46	0:15	11:20:57	11:21:12	0:15	11:21:31	11:21:46	0:15	11:21:57	11:22:12	0:15
Payson St TS	11:21:14	11:21:16	0:02	11:22:05	11:22:16	0:11	11:22:19	11:22:22	0:03	11:21:50	11:22:06	0:16	11:22:16	11:22:28	0:12	11:22:50	11:23:03	0:13	11:23:16	11:23:33	0:17
Pulaski Str TS	11:21:45	11:21:47	0:02	11:22:45	11:22:58	0:13	11:22:51	11:23:03	0:12	11:22:35	11:22:39	0:04	11:22:57	11:23:03	0:06	11:23:32	11:23:44	0:12	11:24:02	11:24:15	0:13
Smallwood St TS	11:22:09	11:22:11	0:02	11:23:20	11:23:27	0:07	11:23:25	11:23:35	0:10	11:23:01	11:23:12	0:11	11:23:25	11:23:29	0:04	11:24:06	11:24:17	0:11	11:24:37	11:24:48	0:11
WB Marc Sta	11:22:29	11:22:49	0:20	11:23:45	11:24:05	0:20	11:23:53	11:24:13	0:20	11:23:30	11:23:50	0:20	11:23:47	11:24:07	0:20	11:24:35	11:24:55	0:20	11:25:06	11:25:26	0:20
Warwick Av TS	11:23:13	11:23:15	0:02	11:24:29	11:24:32	0:03	11:24:37	11:24:40	0:03	11:24:14	11:24:24	0:10	11:24:31	11:24:45	0:14	11:25:19	11:25:27	0:08	11:25:50	11:26:07	0:17
Evergreen Av TS	11:23:48	11:23:50	0:02	11:25:05	11:25:14	0:09	11:25:13	11:25:30	0:17	11:24:57	11:25:02	0:05	11:25:18	11:25:21	0:03	11:26:00	11:26:14	0:14	11:26:40	11:26:58	0:18
Franklintown Rd TS	11:24:17	11:24:19	0:02	11:25:41	11:25:55	0:14	11:25:57	11:26:11	0:14	11:25:29	11:25:40	0:11	11:25:48	11:25:57	0:09	11:26:41	11:26:46	0:05	11:27:25	11:27:39	0:14
Edmondson Av TS	11:24:55	11:24:57	0:02	11:26:31	11:26:37	0:06	11:26:47	11:26:51	0:04	11:26:16	11:26:20	0:04	11:26:33	11:26:36	0:03	11:27:22	11:27:27	0:05	11:28:15	11:28:21	0:06
Rosemont Pl	11:26:00	11:26:15	0:15	11:27:40	11:27:55	0:15	11:27:54	11:28:09	0:15	11:27:23	11:27:38	0:15	11:27:39	11:27:54	0:15	11:28:30	11:28:45	0:15	11:29:24	11:29:39	0:15
Hilton St TS/CS	11:27:14	11:27:16	0:02	11:28:54	11:29:02	0:08	11:29:08	11:29:21	0:13	11:28:37	11:28:54	0:17	11:28:53	11:28:57	0:04	11:29:44	11:30:00	0:16	11:30:38	11:30:55	0:17
Dennison St TS	11:27:36	11:27:38	0:02	11:29:22	11:29:31	0:09	11:29:41	11:29:50	0:09	11:29:14	11:29:21	0:07	11:29:17	11:29:23	0:06	11:30:20	11:30:24	0:04	11:31:15	11:31:24	0:09
Edgewood St TS	11:27:59	11:28:01	0:02	11:29:52	11:30:08	0:16	11:30:11	11:30:22	0:11	11:29:42	11:29:44	0:02	11:29:44	11:29:49	0:05	11:30:45	11:30:58	0:13	11:31:45	11:32:04	0:19
Allendale St TS	11:28:39	11:28:41	0:02	11:30:46	11:30:48	0:02	11:31:00	11:31:02	0:02	11:30:22	11:30:24	0:02	11:30:27	11:30:29	0:02	11:31:36	11:31:38	0:02	11:32:42	11:32:44	0:02
Allendale EB Pl	11:29:05	11:29:20	0:15	11:31:12	11:31:27	0:15	11:31:26	11:31:41	0:15	11:30:48	11:31:03	0:15	11:30:53	11:31:08	0:15	11:32:02	11:32:17	0:15	11:33:08	11:33:23	0:15
Wildwood Pkwy TS	11:30:05	11:30:07	0:02	11:32:12	11:32:27	0:15	11:32:26	11:32:37	0:11	11:31:48	11:32:00	0:12	11:31:53	11:32:09	0:16	11:33:02	11:33:06	0:04	11:34:08	11:34:25	0:17
Athol Av TS	11:31:00	11:31:02	0:02	11:33:20	11:33:27	0:07	11:33:30	11:33:43	0:13	11:32:53	11:33:04	0:11	11:33:02	11:33:07	0:05	11:33:59	11:34:03	0:04	11:35:18	11:35:32	0:14
Edmondson Village	11:31:47	11:32:07	0:20	11:34:12	11:34:32	0:20	11:34:28	11:34:48	0:20	11:33:49	11:34:09	0:20	11:33:52	11:34:12	0:20	11:34:48	11:35:08	0:20	11:36:17	11:36:37	0:20
Swann Ave TS	11:32:28	11:32:30	0:02	11:34:53	11:35:00	0:07	11:35:09	11:35:19	0:10	11:34:30	11:34:33	0:03	11:34:33	11:34:39	0:06	11:35:29	11:35:35	0:06	11:36:58	11:37:08	0:10
I-70 Park-and-Ride	11:35:14	11:35:34	0:20	11:37:44	11:38:04	0:20	11:38:03	11:38:23	0:20	11:37:17	11:37:37	0:20	11:37:23	11:37:43	0:20	11:38:19	11:38:39	0:20	11:39:52	11:40:12	0:20
SSA Pl	11:37:04	11:37:19	0:15	11:39:34	11:39:49	0:15	11:39:53	11:40:08	0:15	11:39:07	11:39:22	0:15	11:39:13	11:39:28	0:15	11:40:09	11:40:24	0:15	11:41:42	11:41:57	0:15
Belmont Av TS	11:39:18	11:39:20	0:02	11:41:48	11:41:52	0:04	11:42:07	11:42:13	0:06	11:41:21	11:41:34	0:13	11:41:27	11:41:36	0:09	11:42:23	11:42:37	0:14	11:43:56	11:44:14	0:18
Security Mall Pl	11:39:39	11:39:54	0:15	11:42:11	11:42:26	0:15	11:42:32	11:42:47	0:15	11:41:53	11:42:08	0:15	11:41:55	11:42:10	0:15	11:42:56	11:43:11	0:15	11:44:33	11:44:48	0:15
Lord Balt Dr TS	11:40:10	11:40:12	0:02	11:42:42	11:42:52	0:10	11:43:03	11:43:22	0:19	11:42:24	11:42:53	0:29	11:42:26	11:42:47	0:21	11:43:27	11:43:59	0:32	11:45:04	11:45:37	0:33
Rolling Rd TS	11:40:43	11:40:45	0:02	11:43:23	11:43:29	0:06	11:43:53	11:43:58	0:05	11:43:24	11:43:27	0:03	11:43:18	11:43:22	0:04	11:44:30	11:44:35	0:05	11:46:08	11:46:14	0:06
Brookdale Rd TS	11:41:15	11:41:17	0:02	11:43:59	11:44:02	0:03	11:44:28	11:44:31	0:03	11:43:57	11:44:00	0:03	11:43:52	11:43:54	0:02	11:45:05	11:45:07	0:02	11:46:44	11:46:47	0:03
Greenage Rd TS	11:41:48	11:41:50	0:02	11:44:33	11:44:42	0:09	11:45:02	11:45:18	0:16	11:44:31	11:44:37	0:06	11:44:25	11:44:39	0:14	11:45:38	11:45:58	0:20	11:47:18	11:47:39	0:21
CMS	11:42:25			11:45:17			11:45:53			11:45:12			11:45:14			11:46:33			11:48:14		

Appendix F
2035 Ridership Forecast


CMS
71
101
69
101
Security Square
146
2
206
2
213
305
Security West
0
0
0
0
213
305
Social Security Administration
279
2
105
15
490
395
I-70 PARK-and-RIDE
39
6
191
2
523
584
Edmondson Village
356
14
356
17
865
923
Allendale
14
7
42
2
872
963
Rosemont
176
52
264
40
996
1187
West Baltimore MARC
235
223
590
49
1008
1728
Harlem Park
23
24
72
23
1007
1777
Poppleton
70
33
24
59
1044
1742
Howard Street/ University Center
357
299
263
459
1102
1546
Inner Harbor
700
445
448
983
1357
1011
Harbor East
62
58
12
206
1361
817
Fell's Point
42
115
27
68
1288
776
Canton
17
109
10
72
1196
714
Brewers Hill Canton Crossing
24
710
39
237
510
516
Highlandtown/ Greektown
20
288
5
313
242
208
Bayview Campus
31
43
0
200
230
8
Bayview MARC
230
8

Appendix G
2021 Operating Plan – Eastbound

Equipment set #		Yard Pull-out	CMS	Security Square	S.S. Administration	I-70 Park-and-Ride	Edmondson Village	Allendale EB	Rosemont	EB MARC Station	Harlem Park	Poppleton	Howard St/ University Center	Inner Harbor	Harbor East	Fell's Point	Canton	Canton Crossing	Highlandtown	Bayview Campus	Bayview MARC	Yard Pull-in	Equipment set #
2	Y001	4:29								4:31	4:34	4:36	4:37	4:38	4:41	4:42	4:44	4:47	4:50	4:53	4:55		**2**
4	Y003	4:44								4:46	4:49	4:51	4:52	4:53	4:56	4:57	4:59	5:02	5:05	5:08	5:10		**4**
6	Y005	4:59								5:01	5:04	5:06	5:07	5:08	5:11	5:12	5:14	5:17	5:20	5:23	5:25		**6**
8	Y007	5:14								5:16	5:19	5:21	5:22	5:23	5:26	5:27	5:29	5:32	5:35	5:38	5:40		**8**
1	002		5:00	5:03	5:06	5:08	5:11	5:14	5:17	5:21	5:24	5:26	5:27	5:28	5:31	5:32	5:34	5:37	5:40	5:43	5:45		**1**
3	004		5:15	5:18	5:21	5:23	5:26	5:29	5:32	5:36	5:39	5:41	5:42	5:43	5:46	5:47	5:49	5:52	5:55	5:58	6:00		**3**
5	006		5:30	5:33	5:36	5:38	5:41	5:44	5:47	5:51	5:54	5:56	5:57	5:58	6:01	6:02	6:04	6:07	6:10	6:13	6:15		**5**
9	Y015	5:59								6:01	6:04	6:06	6:07	6:08	6:11	6:12	6:14	6:17	6:20	6:23	6:25		**9**
7	008		5:45	5:48	5:51	5:53	5:56	5:59	6:02	6:06	6:09	6:11	6:12	6:13	6:16	6:17	6:19	6:22	6:25	6:28	6:30		**7**
2	010		6:00	6:03	6:06	6:08	6:11	6:14	6:17	6:21	6:24	6:26	6:27	6:28	6:31	6:32	6:34	6:37	6:40	6:43	6:45		**2**
10	012		6:10	6:13	6:16	6:18	6:21	6:24	6:27	6:31	6:34	6:36	6:37	6:38	6:41	6:42	6:44	6:47	6:50	6:53	6:55		**10**
4	014		6:20	6:23	6:26	6:28	6:31	6:34	6:37	6:41	6:44	6:46	6:47	6:48	6:51	6:52	6:54	6:57	7:00	7:03	7:05		**4**
6	016		6:30	6:33	6:36	6:38	6:41	6:44	6:47	6:51	6:54	6:56	6:57	6:58	7:01	7:02	7:04	7:07	7:10	7:13	7:15		**6**
12	018		6:40	6:43	6:46	6:48	6:51	6:54	6:57	7:01	7:04	7:06	7:07	7:08	7:11	7:12	7:14	7:17	7:20	7:23	7:25		**12**
8	020		6:50	6:53	6:56	6:58	7:01	7:04	7:07	7:11	7:14	7:16	7:17	7:18	7:21	7:22	7:24	7:27	7:30	7:33	7:35		**8**
1	022		7:00	7:03	7:06	7:08	7:11	7:14	7:17	7:21	7:24	7:26	7:27	7:28	7:31	7:32	7:34	7:37	7:40	7:43	7:45		**1**
3	024		7:10	7:13	7:16	7:18	7:21	7:24	7:27	7:31	7:34	7:36	7:37	7:38	7:41	7:42	7:44	7:47	7:50	7:53	7:55		**3**
5	026		7:20	7:23	7:26	7:28	7:31	7:34	7:37	7:41	7:44	7:46	7:47	7:48	7:51	7:52	7:54	7:57	8:00	8:03	8:05		**5**
9	028		7:30	7:33	7:36	7:38	7:41	7:44	7:47	7:51	7:54	7:56	7:57	7:58	8:01	8:02	8:04	8:07	8:10	8:13	8:15		**9**
7	030		7:40	7:43	7:46	7:48	7:51	7:54	7:57	8:01	8:04	8:06	8:07	8:08	8:11	8:12	8:14	8:17	8:20	8:23	8:25		**7**
2	032		7:50	7:53	7:56	7:58	8:01	8:04	8:07	8:11	8:14	8:16	8:17	8:18	8:21	8:22	8:24	8:27	8:30	8:33	8:35		**2**
10	034		8:00	8:03	8:06	8:08	8:11	8:14	8:17	8:21	8:24	8:26	8:27	8:28	8:31	8:32	8:34	8:37	8:40	8:43	8:45		**10**
4	036		8:10	8:13	8:16	8:18	8:21	8:24	8:27	8:31	8:34	8:36	8:37	8:38	8:41	8:42	8:44	8:47	8:50	8:53	8:55		**4**
6	038		8:20	8:23	8:26	8:28	8:31	8:34	8:37	8:41	8:44	8:46	8:47	8:48	8:51	8:52	8:54	8:57	9:00	9:03	9:05		**6**
12	040		8:30	8:33	8:36	8:38	8:41	8:44	8:47	8:51	8:54	8:56	8:57	8:58	9:01	9:02	9:04	9:07	9:10	9:13	9:15		**12**
8	042		8:40	8:43	8:46	8:48	8:51	8:54	8:57	9:01	9:04	9:06	9:07	9:08	9:11	9:12	9:14	9:17	9:20	9:23	9:25		**8**
1	044		8:50	8:53	8:56	8:58	9:01	9:04	9:07	9:11	9:14	9:16	9:17	9:18	9:21	9:22	9:24	9:27	9:30	9:33	9:35		**1**
3	046		9:00	9:03	9:06	9:08	9:11	9:14	9:17	9:21	9:24	9:26	9:27	9:28	9:31	9:32	9:34	9:37	9:40	9:43	9:45		**3**
5	048		9:10	9:13	9:16	9:18	9:21	9:24	9:27	9:31	9:34	9:36	9:37	9:38	9:41	9:42	9:44	9:47	9:50	9:53	9:55		**5**
9	050		9:20	9:23	9:26	9:28	9:31	9:34	9:37	9:41	9:44	9:46	9:47	9:48	9:51	9:52	9:54	9:57	10:00	10:03	10:05		**9**
7	052		9:30	9:33	9:36	9:38	9:41	9:44	9:47	9:51	9:54	9:56	9:57	9:58	10:01	10:02	10:04	10:07	10:10	10:13	10:15		**7**
2	054		9:40	9:43	9:46	9:48	9:51	9:54	9:57	10:01	10:04	10:06	10:07	10:08	10:11	10:12	10:14	10:17	10:20	10:23	10:25		**2**
10	056		9:50	9:53	9:56	9:58	10:01	10:04	10:07	10:11	10:14	10:16	10:17	10:18	10:21	10:22	10:24	10:27	10:30	10:33	10:35		**10**

Equipment set #		Yard Pull-out	CMS	Security Square	S.S. Administration	I-70 Park-and-Ride	Edmondson Village	Allendale EB	Rosemont	EB MARC Station	Harlem Park	Poppleton	Howard St/ University Center	Inner Harbor	Harbor East	Fell's Point	Canton	Canton Crossing	Highlandtown	Bayview Campus	Bayview MARC	Yard Pull-in	Equipment set #
4	058		10:00	10:03	10:06	10:08	10:11	10:14	10:17	10:21	10:24	10:26	10:27	10:28	10:31	10:32	10:34	10:37	10:40	10:43	10:45		**4**
6	060		10:10	10:13	10:16	10:18	10:21	10:24	10:27	10:31	10:34	10:36	10:37	10:38	10:41	10:42	10:44	10:47	10:50	10:53	10:55		**6**
12	062		10:20	10:23	10:26	10:28	10:31	10:34	10:37	10:41	10:44	10:46	10:47	10:48	10:51	10:52	10:54	10:57	11:00	11:03	11:05		**12**
8	064		10:30	10:33	10:36	10:38	10:41	10:44	10:47	10:51	10:54	10:56	10:57	10:58	11:01	11:02	11:04	11:07	11:10	11:13	11:15		**8**
1	066		10:40	10:43	10:46	10:48	10:51	10:54	10:57	11:01	11:04	11:06	11:07	11:08	11:11	11:12	11:14	11:17	11:20	11:23	11:25		**1**
3	068		10:50	10:53	10:56	10:58	11:01	11:04	11:07	11:11	11:14	11:16	11:17	11:18	11:21	11:22	11:24	11:27	11:30	11:33	11:35		**3**
5	070		11:00	11:03	11:06	11:08	11:11	11:14	11:17	11:21	11:24	11:26	11:27	11:28	11:31	11:32	11:34	11:37	11:40	11:43	11:45		**5**
9	072		11:10	11:13	11:16	11:18	11:21	11:24	11:27	11:31	11:34	11:36	11:37	11:38	11:41	11:42	11:44	11:47	11:50	11:53	11:55		**9**
7	074		11:20	11:23	11:26	11:28	11:31	11:34	11:37	11:41	11:44	11:46	11:47	11:48	11:51	11:52	11:54	11:57	12:00	12:03	12:05		**7**
2	076		11:30	11:33	11:36	11:38	11:41	11:44	11:47	11:51	11:54	11:56	11:57	11:58	12:01	12:02	12:04	12:07	12:10	12:13	12:15		**2**
10	078		11:40	11:43	11:46	11:48	11:51	11:54	11:57	12:01	12:04	12:06	12:07	12:08	12:11	12:12	12:14	12:17	12:20	12:23	12:25		**10**
4	080		11:50	11:53	11:56	11:58	12:01	12:04	12:07	12:11	12:14	12:16	12:17	12:18	12:21	12:22	12:24	12:27	12:30	12:33	12:35		**4**
6	082		12:00	12:03	12:06	12:08	12:11	12:14	12:17	12:21	12:24	12:26	12:27	12:28	12:31	12:32	12:34	12:37	12:40	12:43	12:45		**6**
12	084		12:10	12:13	12:16	12:18	12:21	12:24	12:27	12:31	12:34	12:36	12:37	12:38	12:41	12:42	12:44	12:47	12:50	12:53	12:55		**12**
8	086		12:20	12:23	12:26	12:28	12:31	12:34	12:37	12:41	12:44	12:46	12:47	12:48	12:51	12:52	12:54	12:57	13:00	13:03	13:05		**8**
1	088		12:30	12:33	12:36	12:38	12:41	12:44	12:47	12:51	12:54	12:56	12:57	12:58	13:01	13:02	13:04	13:07	13:10	13:13	13:15		**1**
3	090		12:40	12:43	12:46	12:48	12:51	12:54	12:57	13:01	13:04	13:06	13:07	13:08	13:11	13:12	13:14	13:17	13:20	13:23	13:25		**3**
5	092		12:50	12:53	12:56	12:58	13:01	13:04	13:07	13:11	13:14	13:16	13:17	13:18	13:21	13:22	13:24	13:27	13:30	13:33	13:35		**5**
9	094		13:00	13:03	13:06	13:08	13:11	13:14	13:17	13:21	13:24	13:26	13:27	13:28	13:31	13:32	13:34	13:37	13:40	13:43	13:45		**9**
7	096		13:10	13:13	13:16	13:18	13:21	13:24	13:27	13:31	13:34	13:36	13:37	13:38	13:41	13:42	13:44	13:47	13:50	13:53	13:55		**7**
2	098		13:20	13:23	13:26	13:28	13:31	13:34	13:37	13:41	13:44	13:46	13:47	13:48	13:51	13:52	13:54	13:57	14:00	14:03	14:05		**2**
10	100		13:30	13:33	13:36	13:38	13:41	13:44	13:47	13:51	13:54	13:56	13:57	13:58	14:01	14:02	14:04	14:07	14:10	14:13	14:15		**10**
4	102		13:40	13:43	13:46	13:48	13:51	13:54	13:57	14:01	14:04	14:06	14:07	14:08	14:11	14:12	14:14	14:17	14:20	14:23	14:25		**4**
6	104		13:50	13:53	13:56	13:58	14:01	14:04	14:07	14:11	14:14	14:16	14:17	14:18	14:21	14:22	14:24	14:27	14:30	14:33	14:35		**6**
12	106		14:00	14:03	14:06	14:08	14:11	14:14	14:17	14:21	14:24	14:26	14:27	14:28	14:31	14:32	14:34	14:37	14:40	14:43	14:45		**12**
8	108		14:10	14:13	14:16	14:18	14:21	14:24	14:27	14:31	14:34	14:36	14:37	14:38	14:41	14:42	14:44	14:47	14:50	14:53	14:55		**8**
1	110		14:20	14:23	14:26	14:28	14:31	14:34	14:37	14:41	14:44	14:46	14:47	14:48	14:51	14:52	14:54	14:57	15:00	15:03	15:05		**1**
3	112		14:30	14:33	14:36	14:38	14:41	14:44	14:47	14:51	14:54	14:56	14:57	14:58	15:01	15:02	15:04	15:07	15:10	15:13	15:15		**3**
5	114		14:40	14:43	14:46	14:48	14:51	14:54	14:57	15:01	15:04	15:06	15:07	15:08	15:11	15:12	15:14	15:17	15:20	15:23	15:25		**5**
9	116		14:50	14:53	14:56	14:58	15:01	15:04	15:07	15:11	15:14	15:16	15:17	15:18	15:21	15:22	15:24	15:27	15:30	15:33	15:35		**9**
7	118		15:00	15:03	15:06	15:08	15:11	15:14	15:17	15:21	15:24	15:26	15:27	15:28	15:31	15:32	15:34	15:37	15:40	15:43	15:45		**7**
2	120		15:10	15:13	15:16	15:18	15:21	15:24	15:27	15:31	15:34	15:36	15:37	15:38	15:41	15:42	15:44	15:47	15:50	15:53	15:55		**2**
10	122		15:20	15:23	15:26	15:28	15:31	15:34	15:37	15:41	15:44	15:46	15:47	15:48	15:51	15:52	15:54	15:57	16:00	16:03	16:05		**10**
4	124		15:30	15:33	15:36	15:38	15:41	15:44	15:47	15:51	15:54	15:56	15:57	15:58	16:01	16:02	16:04	16:07	16:10	16:13	16:15		**4**

Equipment set #		Yard Pull-out	CMS	Security Square	S.S. Administration	I-70 Park-and-Ride	Edmondson Village	Allendale EB	Rosemont	EB MARC Station	Harlem Park	Poppleton	Howard St/ University Center	Inner Harbor	Harbor East	Fell's Point	Canton	Canton Crossing	Highlandtown	Bayview Campus	Bayview MARC	Yard Pull-in	Equipment set #
6	126		15:40	15:43	15:46	15:48	15:51	15:54	15:57	16:01	16:04	16:06	16:07	16:08	16:11	16:12	16:14	16:17	16:20	16:23	16:25		**6**
12	128		15:50	15:53	15:56	15:58	16:01	16:04	16:07	16:11	16:14	16:16	16:17	16:18	16:21	16:22	16:24	16:27	16:30	16:33	16:35		**12**
8	130		16:00	16:03	16:06	16:08	16:11	16:14	16:17	16:21	16:24	16:26	16:27	16:28	16:31	16:32	16:34	16:37	16:40	16:43	16:45		**8**
1	132		16:10	16:13	16:16	16:18	16:21	16:24	16:27	16:31	16:34	16:36	16:37	16:38	16:41	16:42	16:44	16:47	16:50	16:53	16:55		**1**
3	134		16:20	16:23	16:26	16:28	16:31	16:34	16:37	16:41	16:44	16:46	16:47	16:48	16:51	16:52	16:54	16:57	17:00	17:03	17:05		**3**
5	136		16:30	16:33	16:36	16:38	16:41	16:44	16:47	16:51	16:54	16:56	16:57	16:58	17:01	17:02	17:04	17:07	17:10	17:13	17:15		**5**
9	138		16:40	16:43	16:46	16:48	16:51	16:54	16:57	17:01	17:04	17:06	17:07	17:08	17:11	17:12	17:14	17:17	17:20	17:23	17:25		**9**
7	140		16:50	16:53	16:56	16:58	17:01	17:04	17:07	17:11	17:14	17:16	17:17	17:18	17:21	17:22	17:24	17:27	17:30	17:33	17:35		**7**
2	142		17:00	17:03	17:06	17:08	17:11	17:14	17:17	17:21	17:24	17:26	17:27	17:28	17:31	17:32	17:34	17:37	17:40	17:43	17:45		**2**
10	144		17:10	17:13	17:16	17:18	17:21	17:24	17:27	17:31	17:34	17:36	17:37	17:38	17:41	17:42	17:44	17:47	17:50	17:53	17:55		**10**
4	146		17:20	17:23	17:26	17:28	17:31	17:34	17:37	17:41	17:44	17:46	17:47	17:48	17:51	17:52	17:54	17:57	18:00	18:03	18:05		**4**
6	148		17:30	17:33	17:36	17:38	17:41	17:44	17:47	17:51	17:54	17:56	17:57	17:58	18:01	18:02	18:04	18:07	18:10	18:13	18:15		**6**
12	150		17:40	17:43	17:46	17:48	17:51	17:54	17:57	18:01	18:04	18:06	18:07	18:08	18:11	18:12	18:14	18:17	18:20	18:23	18:25		**12**
8	152		17:50	17:53	17:56	17:58	18:01	18:04	18:07	18:11	18:14	18:16	18:17	18:18	18:21	18:22	18:24	18:27	18:30	18:33	18:35		**8**
1	154		18:00	18:03	18:06	18:08	18:11	18:14	18:17	18:21	18:24	18:26	18:27	18:28	18:31	18:32	18:34	18:37	18:40	18:43	18:45		**1**
3	156		18:10	18:13	18:16	18:18	18:21	18:24	18:27	18:31	18:34	18:36	18:37	18:38	18:41	18:42	18:44	18:47	18:50	18:53	18:55		**3**
5	158		18:20	18:23	18:26	18:28	18:31	18:34	18:37	18:41	18:44	18:46	18:47	18:48	18:51	18:52	18:54	18:57	19:00	19:03	19:05		**5**
9	160		18:30	18:33	18:36	18:38	18:41	18:44	18:47	18:51	18:54	18:56	18:57	18:58	19:01	19:02	19:04	19:07	19:10	19:13	19:15		**9**
7	162		18:40	18:43	18:46	18:48	18:51	18:54	18:57	19:01	19:04	19:06	19:07	19:08	19:11	19:12	19:14	19:17	19:20	19:23	19:25		**7**
2	164		18:50	18:53	18:56	18:58	19:01	19:04	19:07	19:11	19:14	19:16	19:17	19:18	19:21	19:22	19:24	19:27	19:30	19:33	19:35		**2**
10	166		19:00	19:03	19:06	19:08	19:11	19:14	19:17	19:21	19:24	19:26	19:27	19:28	19:31	19:32	19:34	19:37	19:40	19:43	19:45		**10**
4	168		19:10	19:13	19:16	19:18	19:21	19:24	19:27	19:31	19:34	19:36	19:37	19:38	19:41	19:42	19:44	19:47	19:50	19:53	19:55		**4**
6	170		19:20	19:23	19:26	19:28	19:31	19:34	19:37	19:41	19:44	19:46	19:47	19:48	19:51	19:52	19:54	19:57	20:00	20:03	20:05		**6**
12	172		19:30	19:33	19:36	19:38	19:41	19:44	19:47	19:51	19:54	19:56	19:57	19:58	20:01	20:02	20:04	20:07	20:10	20:13	20:15		**12**
8	174		19:40	19:43	19:46	19:48	19:51	19:54	19:57	20:01	20:04	20:06	20:07	20:08	20:11	20:12	20:14	20:17	20:20	20:23	20:25		**8**
1	176		19:50	19:53	19:56	19:58	20:01	20:04	20:07	20:11	20:14	20:16	20:17	20:18	20:21	20:22	20:24	20:27	20:30	20:33	20:35		**1**
3	178		20:00	20:03	20:06	20:08	20:11	20:14	20:17	20:21	20:24	20:26	20:27	20:28	20:31	20:32	20:34	20:37	20:40	20:43	20:45		**3**
5	180		20:10	20:13	20:16	20:18	20:21	20:24	20:27	20:31	20:34	20:36	20:37	20:38	20:41	20:42	20:44	20:47	20:50	20:53	20:55		**5**
9	182		20:20	20:23	20:26	20:28	20:31	20:34	20:37	20:41	20:44	20:46	20:47	20:48	20:51	20:52	20:54	20:57	21:00	21:03	21:05		**9**
7	184		20:30	20:33	20:36	20:38	20:41	20:44	20:47	20:51	20:54	20:56	20:57	20:58	21:01	21:02	21:04	21:07	21:10	21:13	21:15		**7**
2	186		20:40	20:43	20:46	20:48	20:51	20:54	20:57	21:01	21:04	21:06	21:07	21:08	21:11	21:12	21:14	21:17	21:20	21:23	21:25		**2**
10	188		20:50	20:53	20:56	20:58	21:01	21:04	21:07	21:11	21:14	21:16	21:17	21:18	21:21	21:22	21:24	21:27	21:30	21:33	21:35		**10**
4	190		21:00	21:03	21:06	21:08	21:11	21:14	21:17	21:21	21:24	21:26	21:27	21:28	21:31	21:32	21:34	21:37	21:40	21:43	21:45		**4**
6	192		21:15	21:18	21:21	21:23	21:26	21:29	21:32	21:36	21:39	21:41	21:42	21:43	21:46	21:47	21:49	21:52	21:55	21:58	22:00		**6**

Equipment set #		Yard Pull-out	CMS	Security Square	S.S. Administration	I-70 Park-and-Ride	Edmondson Village	Allendale EB	Rosemont	EB MARC Station	Harlem Park	Poppleton	Howard St/ University Center	Inner Harbor	Harbor East	Fell's Point	Canton	Canton Crossing	Highlandtown	Bayview Campus	Bayview MARC	Yard Pull-in	Equipment set #
12	Y181		21:20	21:23	21:26	21:28	21:31	21:34	21:37													21:38	**12**
8	194		21:30	21:33	21:36	21:38	21:41	21:44	21:47	21:51	21:54	21:56	21:57	21:58	22:01	22:02	22:04	22:07	22:10	22:13	22:15		**8**
1	196		21:45	21:48	21:51	21:53	21:56	21:59	22:02	22:06	22:09	22:11	22:12	22:13	22:16	22:17	22:19	22:22	22:25	22:28	22:30		**1**
3	Y187		21:50	21:53	21:56	21:58	22:01	22:04	22:07													22:08	**3**
5	198		22:00	22:03	22:06	22:08	22:11	22:14	22:17	22:21	22:24	22:26	22:27	22:28	22:31	22:32	22:34	22:37	22:40	22:43	22:45		**5**
9	200		22:15	22:18	22:21	22:23	22:26	22:29	22:32	22:36	22:39	22:41	22:42	22:43	22:46	22:47	22:49	22:52	22:55	22:58	23:00		**9**
2	202		22:30	22:33	22:36	22:38	22:41	22:44	22:47	22:51	22:54	22:56	22:57	22:58	23:01	23:02	23:04	23:07	23:10	23:13	23:15		**2**
10	204		22:45	22:48	22:51	22:53	22:56	22:59	23:02	23:06	23:09	23:11	23:12	23:13	23:16	23:17	23:19	23:22	23:25	23:28	23:30		**10**
4	206		23:00	23:03	23:06	23:08	23:11	23:14	23:17	23:21	23:24	23:26	23:27	23:28	23:31	23:32	23:34	23:37	23:40	23:43	23:45		**4**
6	208		23:15	23:18	23:21	23:23	23:26	23:29	23:32	23:36	23:39	23:41	23:42	23:43	23:46	23:47	23:49	23:52	23:55	23:58	0:00		**6**
8	210		23:30	23:33	23:36	23:38	23:41	23:44	23:47	23:51	23:54	23:56	23:57	23:58	0:01	0:02	0:04	0:07	0:10	0:13	0:15		**8**
1	212		23:45	23:48	23:51	23:53	23:56	23:59	0:02	0:06	0:09	0:11	0:12	0:13	0:16	0:17	0:19	0:22	0:25	0:28	0:30		**1**
5	214		0:00	0:03	0:06	0:08	0:11	0:14	0:17	0:21	0:24	0:26	0:27	0:28	0:31	0:32	0:34	0:37	0:40	0:43	0:45		
9	216		0:15	0:18	0:21	0:23	0:26	0:29	0:32	0:36	0:39	0:41	0:42	0:43	0:46	0:47	0:49	0:52	0:55	0:58	1:00		**9**
2	218		0:30	0:33	0:36	0:38	0:41	0:44	0:47	0:51	0:54	0:56	0:57	0:58	1:01	1:02	1:04	1:07	1:10	1:13	1:15		**2**
10	220		0:45	0:48	0:51	0:53	0:56	0:59	1:02	1:06	1:09	1:11	1:12	1:13	1:16	1:17	1:19	1:22	1:25	1:28	1:30		**10**
4	222		1:00	1:03	1:06	1:08	1:11	1:14	1:17	1:21	1:24	1:26	1:27	1:28	1:31	1:32	1:34	1:37	1:40	1:43	1:45		**4**
6	Y215		1:15	1:18	1:21	1:23	1:26	1:29	1:32													1:33	**6**
8	Y217		1:30	1:33	1:36	1:38	1:41	1:44	1:47													1:48	**8**
1	Y219		1:45	1:48	1:51	1:53	1:56	1:59	2:02													2:03	**1**

Appendix H
2021 Operating Plan – Westbound

Equipment set #		Yard Pull-out	Bayview MARC	Bayview Campus	Highlandtown	Canton Crossing	Canton	Fell's Point	Harbor East	Inner Harbor	Howard St/ University Center	Poppleton	Harlem Park	EB MARC Station	Rosemont	Allendale EB	Edmondson Village	I-70 Park-and-Ride	S.S. Administration	Security Sqyare	CMS	Yard Pull-in	Equipment set #
1	Y002	4:31													4:32	4:36	4:38	4:42	4:44	4:46	4:50		**1**
3	Y004	4:46													4:47	4:51	4:53	4:57	4:59	5:01	5:05		**3**
5	Y006	5:01													5:02	5:06	5:08	5:12	5:14	5:16	5:20		**5**
7	Y008	5:16													5:17	5:21	5:23	5:27	5:29	5:31	5:35		**7**
2	001		5:05	5:07	5:09	5:12	5:16	5:18	5:19	5:21	5:22	5:24	5:26	5:29	5:32	5:36	5:38	5:42	5:44	5:46	5:50		**2**
10	Y012	5:41													5:42	5:46	5:48	5:52	5:54	5:56	6:00		**10**
4	003		5:20	5:22	5:24	5:27	5:31	5:33	5:34	5:36	5:37	5:39	5:41	5:44	5:47	5:51	5:53	5:57	5:59	6:01	6:05		**4**
6	005		5:35	5:37	5:39	5:42	5:46	5:48	5:49	5:51	5:52	5:54	5:56	5:59	6:02	6:06	6:08	6:12	6:14	6:16	6:20		**6**
12	Y018	6:11													6:12	6:16	6:18	6:22	6:24	6:26	6:30		**12**
8	007		5:50	5:52	5:54	5:57	6:01	6:03	6:04	6:06	6:07	6:09	6:11	6:14	6:17	6:21	6:23	6:27	6:29	6:31	6:35		**8**
1	009		6:05	6:07	6:09	6:12	6:16	6:18	6:19	6:21	6:22	6:24	6:26	6:29	6:32	6:36	6:38	6:42	6:44	6:46	6:50		**1**
3	011		6:15	6:17	6:19	6:22	6:26	6:28	6:29	6:31	6:32	6:34	6:36	6:39	6:42	6:46	6:48	6:52	6:54	6:56	7:00		**3**
5	013		6:25	6:27	6:29	6:32	6:36	6:38	6:39	6:41	6:42	6:44	6:46	6:49	6:52	6:56	6:58	7:02	7:04	7:06	7:10		**5**
9	015		6:35	6:37	6:39	6:42	6:46	6:48	6:49	6:51	6:52	6:54	6:56	6:59	7:02	7:06	7:08	7:12	7:14	7:16	7:20		**9**
7	017		6:45	6:47	6:49	6:52	6:56	6:58	6:59	7:01	7:02	7:04	7:06	7:09	7:12	7:16	7:18	7:22	7:24	7:26	7:30		**7**
2	019		6:55	6:57	6:59	7:02	7:06	7:08	7:09	7:11	7:12	7:14	7:16	7:19	7:22	7:26	7:28	7:32	7:34	7:36	7:40		**2**
10	021		7:05	7:07	7:09	7:12	7:16	7:18	7:19	7:21	7:22	7:24	7:26	7:29	7:32	7:36	7:38	7:42	7:44	7:46	7:50		**10**
4	023		7:15	7:17	7:19	7:22	7:26	7:28	7:29	7:31	7:32	7:34	7:36	7:39	7:42	7:46	7:48	7:52	7:54	7:56	8:00		**4**
6	025		7:25	7:27	7:29	7:32	7:36	7:38	7:39	7:41	7:42	7:44	7:46	7:49	7:52	7:56	7:58	8:02	8:04	8:06	8:10		**6**
12	027		7:35	7:37	7:39	7:42	7:46	7:48	7:49	7:51	7:52	7:54	7:56	7:59	8:02	8:06	8:08	8:12	8:14	8:16	8:20		**12**
8	029		7:45	7:47	7:49	7:52	7:56	7:58	7:59	8:01	8:02	8:04	8:06	8:09	8:12	8:16	8:18	8:22	8:24	8:26	8:30		**8**
1	031		7:55	7:57	7:59	8:02	8:06	8:08	8:09	8:11	8:12	8:14	8:16	8:19	8:22	8:26	8:28	8:32	8:34	8:36	8:40		**1**
3	033		8:05	8:07	8:09	8:12	8:16	8:18	8:19	8:21	8:22	8:24	8:26	8:29	8:32	8:36	8:38	8:42	8:44	8:46	8:50		**3**
5	035		8:15	8:17	8:19	8:22	8:26	8:28	8:29	8:31	8:32	8:34	8:36	8:39	8:42	8:46	8:48	8:52	8:54	8:56	9:00		**5**
9	037		8:25	8:27	8:29	8:32	8:36	8:38	8:39	8:41	8:42	8:44	8:46	8:49	8:52	8:56	8:58	9:02	9:04	9:06	9:10		**9**
7	039		8:35	8:37	8:39	8:42	8:46	8:48	8:49	8:51	8:52	8:54	8:56	8:59	9:02	9:06	9:08	9:12	9:14	9:16	9:20		**7**
2	041		8:45	8:47	8:49	8:52	8:56	8:58	8:59	9:01	9:02	9:04	9:06	9:09	9:12	9:16	9:18	9:22	9:24	9:26	9:30		**2**
10	043		8:55	8:57	8:59	9:02	9:06	9:08	9:09	9:11	9:12	9:14	9:16	9:19	9:22	9:26	9:28	9:32	9:34	9:36	9:40		**10**
4	045		9:05	9:07	9:09	9:12	9:16	9:18	9:19	9:21	9:22	9:24	9:26	9:29	9:32	9:36	9:38	9:42	9:44	9:46	9:50		**4**
6	047		9:15	9:17	9:19	9:22	9:26	9:28	9:29	9:31	9:32	9:34	9:36	9:39	9:42	9:46	9:48	9:52	9:54	9:56	10:00		**6**
12	049		9:25	9:27	9:29	9:32	9:36	9:38	9:39	9:41	9:42	9:44	9:46	9:49	9:52	9:56	9:58	10:02	10:04	10:06	10:10	9:50	**12**
8	051		9:35	9:37	9:39	9:42	9:46	9:48	9:49	9:51	9:52	9:54	9:56	9:59	10:02	10:06	10:08	10:12	10:14	10:16	10:20		**8**
1	053		9:45	9:47	9:49	9:52	9:56	9:58	9:59	10:01	10:02	10:04	10:06	10:09	10:12	10:16	10:18	10:22	10:24	10:26	10:30		**1**

Equipment set #		Yard Pull-out	Bayview MARC	Bayview Campus	Highlandtown	Canton Crossing	Canton	Fell's Point	Harbor East	Inner Harbor	Howard St/ University Center	Poppleton	Harlem Park	EB MARC Station	Rosemont	Allendale EB	Edmondson Village	I-70 Park-and-Ride	S.S. Administration	Security Sqyare	CMS	Yard Pull-in	Equipment set #
3	055		9:55	9:57	9:59	10:02	10:06	10:08	10:09	10:11	10:12	10:14	10:16	10:19	10:22	10:26	10:28	10:32	10:34	10:36	10:40		**3**
5	057		10:05	10:07	10:09	10:12	10:16	10:18	10:19	10:21	10:22	10:24	10:26	10:29	10:32	10:36	10:38	10:42	10:44	10:46	10:50		**5**
9	059		10:15	10:17	10:19	10:22	10:26	10:28	10:29	10:31	10:32	10:34	10:36	10:39	10:42	10:46	10:48	10:52	10:54	10:56	11:00		**9**
7	061		10:25	10:27	10:29	10:32	10:36	10:38	10:39	10:41	10:42	10:44	10:46	10:49	10:52	10:56	10:58	11:02	11:04	11:06	11:10		**7**
2	063		10:35	10:37	10:39	10:42	10:46	10:48	10:49	10:51	10:52	10:54	10:56	10:59	11:02	11:06	11:08	11:12	11:14	11:16	11:20		**2**
10	065		10:45	10:47	10:49	10:52	10:56	10:58	10:59	11:01	11:02	11:04	11:06	11:09	11:12	11:16	11:18	11:22	11:24	11:26	11:30		**10**
4	067		10:55	10:57	10:59	11:02	11:06	11:08	11:09	11:11	11:12	11:14	11:16	11:19	11:22	11:26	11:28	11:32	11:34	11:36	11:40		**4**
6	069		11:05	11:07	11:09	11:12	11:16	11:18	11:19	11:21	11:22	11:24	11:26	11:29	11:32	11:36	11:38	11:42	11:44	11:46	11:50		**6**
12	071		11:15	11:17	11:19	11:22	11:26	11:28	11:29	11:31	11:32	11:34	11:36	11:39	11:42	11:46	11:48	11:52	11:54	11:56	12:00		**12**
8	073		11:25	11:27	11:29	11:32	11:36	11:38	11:39	11:41	11:42	11:44	11:46	11:49	11:52	11:56	11:58	12:02	12:04	12:06	12:10		**8**
1	075		11:35	11:37	11:39	11:42	11:46	11:48	11:49	11:51	11:52	11:54	11:56	11:59	12:02	12:06	12:08	12:12	12:14	12:16	12:20		**1**
3	077		11:45	11:47	11:49	11:52	11:56	11:58	11:59	12:01	12:02	12:04	12:06	12:09	12:12	12:16	12:18	12:22	12:24	12:26	12:30		**3**
5	079		11:55	11:57	11:59	12:02	12:06	12:08	12:09	12:11	12:12	12:14	12:16	12:19	12:22	12:26	12:28	12:32	12:34	12:36	12:40		**5**
9	081		12:05	12:07	12:09	12:12	12:16	12:18	12:19	12:21	12:22	12:24	12:26	12:29	12:32	12:36	12:38	12:42	12:44	12:46	12:50		**9**
7	083		12:15	12:17	12:19	12:22	12:26	12:28	12:29	12:31	12:32	12:34	12:36	12:39	12:42	12:46	12:48	12:52	12:54	12:56	13:00		**7**
2	085		12:25	12:27	12:29	12:32	12:36	12:38	12:39	12:41	12:42	12:44	12:46	12:49	12:52	12:56	12:58	13:02	13:04	13:06	13:10		**2**
10	087		12:35	12:37	12:39	12:42	12:46	12:48	12:49	12:51	12:52	12:54	12:56	12:59	13:02	13:06	13:08	13:12	13:14	13:16	13:20		**10**
4	089		12:45	12:47	12:49	12:52	12:56	12:58	12:59	13:01	13:02	13:04	13:06	13:09	13:12	13:16	13:18	13:22	13:24	13:26	13:30		**4**
6	091		12:55	12:57	12:59	13:02	13:06	13:08	13:09	13:11	13:12	13:14	13:16	13:19	13:22	13:26	13:28	13:32	13:34	13:36	13:40		**6**
12	093		13:05	13:07	13:09	13:12	13:16	13:18	13:19	13:21	13:22	13:24	13:26	13:29	13:32	13:36	13:38	13:42	13:44	13:46	13:50		**12**
8	095		13:15	13:17	13:19	13:22	13:26	13:28	13:29	13:31	13:32	13:34	13:36	13:39	13:42	13:46	13:48	13:52	13:54	13:56	14:00		**8**
1	097		13:25	13:27	13:29	13:32	13:36	13:38	13:39	13:41	13:42	13:44	13:46	13:49	13:52	13:56	13:58	14:02	14:04	14:06	14:10		**1**
3	099		13:35	13:37	13:39	13:42	13:46	13:48	13:49	13:51	13:52	13:54	13:56	13:59	14:02	14:06	14:08	14:12	14:14	14:16	14:20		**3**
5	101		13:45	13:47	13:49	13:52	13:56	13:58	13:59	14:01	14:02	14:04	14:06	14:09	14:12	14:16	14:18	14:22	14:24	14:26	14:30		**5**
9	103		13:55	13:57	13:59	14:02	14:06	14:08	14:09	14:11	14:12	14:14	14:16	14:19	14:22	14:26	14:28	14:32	14:34	14:36	14:40		**9**
7	105		14:05	14:07	14:09	14:12	14:16	14:18	14:19	14:21	14:22	14:24	14:26	14:29	14:32	14:36	14:38	14:42	14:44	14:46	14:50		**7**
2	107		14:15	14:17	14:19	14:22	14:26	14:28	14:29	14:31	14:32	14:34	14:36	14:39	14:42	14:46	14:48	14:52	14:54	14:56	15:00		**2**
10	109		14:25	14:27	14:29	14:32	14:36	14:38	14:39	14:41	14:42	14:44	14:46	14:49	14:52	14:56	14:58	15:02	15:04	15:06	15:10		**10**
4	111		14:35	14:37	14:39	14:42	14:46	14:48	14:49	14:51	14:52	14:54	14:56	14:59	15:02	15:06	15:08	15:12	15:14	15:16	15:20		**4**
6	113		14:45	14:47	14:49	14:52	14:56	14:58	14:59	15:01	15:02	15:04	15:06	15:09	15:12	15:16	15:18	15:22	15:24	15:26	15:30		**6**
12	115		14:55	14:57	14:59	15:02	15:06	15:08	15:09	15:11	15:12	15:14	15:16	15:19	15:22	15:26	15:28	15:32	15:34	15:36	15:40		**12**
8	117		15:05	15:07	15:09	15:12	15:16	15:18	15:19	15:21	15:22	15:24	15:26	15:29	15:32	15:36	15:38	15:42	15:44	15:46	15:50		**8**
1	119		15:15	15:17	15:19	15:22	15:26	15:28	15:29	15:31	15:32	15:34	15:36	15:39	15:42	15:46	15:48	15:52	15:54	15:56	16:00		**1**
3	121		15:25	15:27	15:29	15:32	15:36	15:38	15:39	15:41	15:42	15:44	15:46	15:49	15:52	15:56	15:58	16:02	16:04	16:06	16:10		**3**

Equipment set #		Yard Pull-out	Bayview MARC	Bayview Campus	Highlandtown	Canton Crossing	Canton	Fell's Point	Harbor East	Inner Harbor	Howard St/ University Center	Poppleton	Harlem Park	EB MARC Station	Rosemont	Allendale EB	Edmondson Village	I-70 Park-and-Ride	S.S. Administration	Security Sqyare	CMS	Yard Pull-in	Equipment set #
5	123		15:35	15:37	15:39	15:42	15:46	15:48	15:49	15:51	15:52	15:54	15:56	15:59	16:02	16:06	16:08	16:12	16:14	16:16	16:20		**5**
9	125		15:45	15:47	15:49	15:52	15:56	15:58	15:59	16:01	16:02	16:04	16:06	16:09	16:12	16:16	16:18	16:22	16:24	16:26	16:30		**9**
7	127		15:55	15:57	15:59	16:02	16:06	16:08	16:09	16:11	16:12	16:14	16:16	16:19	16:22	16:26	16:28	16:32	16:34	16:36	16:40		**7**
2	129		16:05	16:07	16:09	16:12	16:16	16:18	16:19	16:21	16:22	16:24	16:26	16:29	16:32	16:36	16:38	16:42	16:44	16:46	16:50		**2**
10	131		16:15	16:17	16:19	16:22	16:26	16:28	16:29	16:31	16:32	16:34	16:36	16:39	16:42	16:46	16:48	16:52	16:54	16:56	17:00		**10**
4	133		16:25	16:27	16:29	16:32	16:36	16:38	16:39	16:41	16:42	16:44	16:46	16:49	16:52	16:56	16:58	17:02	17:04	17:06	17:10		**4**
6	135		16:35	16:37	16:39	16:42	16:46	16:48	16:49	16:51	16:52	16:54	16:56	16:59	17:02	17:06	17:08	17:12	17:14	17:16	17:20		**6**
12	137		16:45	16:47	16:49	16:52	16:56	16:58	16:59	17:01	17:02	17:04	17:06	17:09	17:12	17:16	17:18	17:22	17:24	17:26	17:30		**12**
8	139		16:55	16:57	16:59	17:02	17:06	17:08	17:09	17:11	17:12	17:14	17:16	17:19	17:22	17:26	17:28	17:32	17:34	17:36	17:40		**8**
1	141		17:05	17:07	17:09	17:12	17:16	17:18	17:19	17:21	17:22	17:24	17:26	17:29	17:32	17:36	17:38	17:42	17:44	17:46	17:50		**1**
3	143		17:15	17:17	17:19	17:22	17:26	17:28	17:29	17:31	17:32	17:34	17:36	17:39	17:42	17:46	17:48	17:52	17:54	17:56	18:00		**3**
5	145		17:25	17:27	17:29	17:32	17:36	17:38	17:39	17:41	17:42	17:44	17:46	17:49	17:52	17:56	17:58	18:02	18:04	18:06	18:10		**5**
9	147		17:35	17:37	17:39	17:42	17:46	17:48	17:49	17:51	17:52	17:54	17:56	17:59	18:02	18:06	18:08	18:12	18:14	18:16	18:20		**9**
7	149		17:45	17:47	17:49	17:52	17:56	17:58	17:59	18:01	18:02	18:04	18:06	18:09	18:12	18:16	18:18	18:22	18:24	18:26	18:30		**7**
2	151		17:55	17:57	17:59	18:02	18:06	18:08	18:09	18:11	18:12	18:14	18:16	18:19	18:22	18:26	18:28	18:32	18:34	18:36	18:40		**2**
10	153		18:05	18:07	18:09	18:12	18:16	18:18	18:19	18:21	18:22	18:24	18:26	18:29	18:32	18:36	18:38	18:42	18:44	18:46	18:50		**10**
4	155		18:15	18:17	18:19	18:22	18:26	18:28	18:29	18:31	18:32	18:34	18:36	18:39	18:42	18:46	18:48	18:52	18:54	18:56	19:00		**4**
6	157		18:25	18:27	18:29	18:32	18:36	18:38	18:39	18:41	18:42	18:44	18:46	18:49	18:52	18:56	18:58	19:02	19:04	19:06	19:10		**6**
12	159		18:35	18:37	18:39	18:42	18:46	18:48	18:49	18:51	18:52	18:54	18:56	18:59	19:02	19:06	19:08	19:12	19:14	19:16	19:20		**12**
8	161		18:45	18:47	18:49	18:52	18:56	18:58	18:59	19:01	19:02	19:04	19:06	19:09	19:12	19:16	19:18	19:22	19:24	19:26	19:30		**8**
1	163		18:55	18:57	18:59	19:02	19:06	19:08	19:09	19:11	19:12	19:14	19:16	19:19	19:22	19:26	19:28	19:32	19:34	19:36	19:40		**1**
3	165		19:05	19:07	19:09	19:12	19:16	19:18	19:19	19:21	19:22	19:24	19:26	19:29	19:32	19:36	19:38	19:42	19:44	19:46	19:50		**3**
5	167		19:15	19:17	19:19	19:22	19:26	19:28	19:29	19:31	19:32	19:34	19:36	19:39	19:42	19:46	19:48	19:52	19:54	19:56	20:00		**5**
9	169		19:25	19:27	19:29	19:32	19:36	19:38	19:39	19:41	19:42	19:44	19:46	19:49	19:52	19:56	19:58	20:02	20:04	20:06	20:10		**9**
7	171		19:35	19:37	19:39	19:42	19:46	19:48	19:49	19:51	19:52	19:54	19:56	19:59	20:02	20:06	20:08	20:12	20:14	20:16	20:20		**7**
2	173		19:45	19:47	19:49	19:52	19:56	19:58	19:59	20:01	20:02	20:04	20:06	20:09	20:12	20:16	20:18	20:22	20:24	20:26	20:30		**2**
10	175		19:55	19:57	19:59	20:02	20:06	20:08	20:09	20:11	20:12	20:14	20:16	20:19	20:22	20:26	20:28	20:32	20:34	20:36	20:40		**10**
4	177		20:05	20:07	20:09	20:12	20:16	20:18	20:19	20:21	20:22	20:24	20:26	20:29	20:32	20:36	20:38	20:42	20:44	20:46	20:50		**4**
6	179		20:15	20:17	20:19	20:22	20:26	20:28	20:29	20:31	20:32	20:34	20:36	20:39	20:42	20:46	20:48	20:52	20:54	20:56	21:00		**6**
12	181		20:25	20:27	20:29	20:32	20:36	20:38	20:39	20:41	20:42	20:44	20:46	20:49	20:52	20:56	20:58	21:02	21:04	21:06	21:10		**12**
8	183		20:35	20:37	20:39	20:42	20:46	20:48	20:49	20:51	20:52	20:54	20:56	20:59	21:02	21:06	21:08	21:12	21:14	21:16	21:20		**8**
1	185		20:45	20:47	20:49	20:52	20:56	20:58	20:59	21:01	21:02	21:04	21:06	21:09	21:12	21:16	21:18	21:22	21:24	21:26	21:30		**1**
3	187		20:55	20:57	20:59	21:02	21:06	21:08	21:09	21:11	21:12	21:14	21:16	21:19	21:22	21:26	21:28	21:32	21:34	21:36	21:40		**3**
5	189		21:05	21:07	21:09	21:12	21:16	21:18	21:19	21:21	21:22	21:24	21:26	21:29	21:32	21:36	21:38	21:42	21:44	21:46	21:50		**5**

Equipment set #		Yard Pull-out	Bayview MARC	Bayview Campus	Highlandtown	Canton Crossing	Canton	Fell's Point	Harbor East	Inner Harbor	Howard St/ University Center	Poppleton	Harlem Park	EB MARC Station	Rosemont	Allendale EB	Edmondson Village	I-70 Park-and-Ride	S.S. Administration	Security Sqyare	CMS	Yard Pull-in	Equipment set #
9	191		21:20	21:22	21:24	21:27	21:31	21:33	21:34	21:36	21:37	21:39	21:41	21:44	21:47	21:51	21:53	21:57	21:59	22:01	22:05		**9**
7	Y184		21:25	21:27	21:29	21:32	21:36	21:38	21:39	21:41	21:42	21:44	21:46	21:49								21:50	**7**
2	193		21:35	21:37	21:39	21:42	21:46	21:48	21:49	21:51	21:52	21:54	21:56	21:59	22:02	22:06	22:08	22:12	22:14	22:16	22:20		**2**
10	195		21:50	21:52	21:54	21:57	22:01	22:03	22:04	22:06	22:07	22:09	22:11	22:14	22:17	22:21	22:23	22:27	22:29	22:31	22:35		**10**
4	197		22:05	22:07	22:09	22:12	22:16	22:18	22:19	22:21	22:22	22:24	22:26	22:29	22:32	22:36	22:38	22:42	22:44	22:46	22:50		**4**
6	199		22:20	22:22	22:24	22:27	22:31	22:33	22:34	22:36	22:37	22:39	22:41	22:44	22:47	22:51	22:53	22:57	22:59	23:01	23:05		**6**
8	201		22:35	22:37	22:39	22:42	22:46	22:48	22:49	22:51	22:52	22:54	22:56	22:59	23:02	23:06	23:08	23:12	23:14	23:16	23:20		**8**
1	203		22:50	22:52	22:54	22:57	23:01	23:03	23:04	23:06	23:07	23:09	23:11	23:14	23:17	23:21	23:23	23:27	23:29	23:31	23:35		**1**
5	205		23:05	23:07	23:09	23:12	23:16	23:18	23:19	23:21	23:22	23:24	23:26	23:29	23:32	23:36	23:38	23:42	23:44	23:46	23:50		**5**
9	207		23:20	23:22	23:24	23:27	23:31	23:33	23:34	23:36	23:37	23:39	23:41	23:44	23:47	23:51	23:53	23:57	23:59	0:01	0:05		**9**
2	209		23:35	23:37	23:39	23:42	23:46	23:48	23:49	23:51	23:52	23:54	23:56	23:59	0:02	0:06	0:08	0:12	0:14	0:16	0:20		**2**
10	211		23:50	23:52	23:54	23:57	0:01	0:03	0:04	0:06	0:07	0:09	0:11	0:14	0:17	0:21	0:23	0:27	0:29	0:31	0:35		**10**
4	213		0:05	0:07	0:09	0:12	0:16	0:18	0:19	0:21	0:22	0:24	0:26	0:29	0:32	0:36	0:38	0:42	0:44	0:46	0:50		**4**
6	215		0:20	0:22	0:24	0:27	0:31	0:33	0:34	0:36	0:37	0:39	0:41	0:44	0:47	0:51	0:53	0:57	0:59	1:01	1:05		**6**
8	217		0:35	0:37	0:39	0:42	0:46	0:48	0:49	0:51	0:52	0:54	0:56	0:59	1:02	1:06	1:08	1:12	1:14	1:16	1:20		**8**
1	219		0:50	0:52	0:54	0:57	1:01	1:03	1:04	1:06	1:07	1:09	1:11	1:14	1:17	1:21	1:23	1:27	1:29	1:31	1:35		**1**
5	Y214		1:05	1:07	1:09	1:12	1:16	1:18	1:19	1:21	1:22	1:24	1:26	1:29								1:30	**5**
9	Y216		1:10	1:12	1:14	1:17	1:21	1:23	1:24	1:26	1:27	1:29	1:31	1:34								1:35	**9**
2	Y218		1:25	1:27	1:29	1:32	1:36	1:38	1:39	1:41	1:42	1:44	1:46	1:49								1:50	**2**
10	Y220		1:40	1:42	1:44	1:47	1:51	1:53	1:54	1:56	1:57	1:59	2:01	2:04								2:05	**10**
4	Y222		1:55	1:57	1:59	2:02	2:06	2:08	2:09	2:11	2:12	2:14	2:16	2:19								2:20	**4**

Appendix I: 2035 Operating Plan – Eastbound

Equipment set #		Yard Pull-out	CMS	Security Square	S.S. Administration	I-70 Park-and-Ride	Edmondson Village	Allendale EB	Rosemont	EB MARC Sta	Harlem Park	Poppleton	Howard St/ University Center	Inner Harbor	Harbor East	Fell's Point	Canton	Canton Crossing	Highlandtown	Bayview Campus	Bayview MARC	Yard Pull-in	Equipment set #
1	Y001	4:29								4:31	4:34	4:36	4:37	4:38	4:41	4:42	4:44	4:47	4:50	4:53	4:55		**1**
3	Y003	4:44								4:46	4:49	4:51	4:52	4:53	4:56	4:57	4:59	5:02	5:05	5:08	5:10		**3**
5	Y005	4:59								5:01	5:04	5:06	5:07	5:08	5:11	5:12	5:14	5:17	5:20	5:23	5:25		**5**
7	Y007	5:14								5:16	5:19	5:21	5:22	5:23	5:26	5:27	5:29	5:32	5:35	5:38	5:40		**7**
2	002		5:00	5:03	5:06	5:08	5:11	5:14	5:17	5:21	5:24	5:26	5:27	5:28	5:31	5:32	5:34	5:37	5:40	5:43	5:45		**2**
4	004		5:15	5:18	5:21	5:23	5:26	5:29	5:32	5:36	5:39	5:41	5:42	5:43	5:46	5:47	5:49	5:52	5:55	5:58	6:00		**4**
10	Y013	5:41								5:43	5:46	5:48	5:49	5:50	5:53	5:54	5:56	5:59	6:02	6:05	6:07		**10**
6	006		5:30	5:33	5:36	5:38	5:41	5:44	5:47	5:51	5:54	5:56	5:57	5:58	6:01	6:02	6:04	6:07	6:10	6:13	6:15		**6**
12	Y017	5:56								5:58	6:01	6:03	6:04	6:05	6:08	6:09	6:11	6:14	6:17	6:20	6:22		**12**
8	008		5:45	5:48	5:51	5:53	5:56	5:59	6:02	6:06	6:09	6:11	6:12	6:13	6:16	6:17	6:19	6:22	6:25	6:28	6:30		**8**
14	Y021	6:11								6:13	6:16	6:18	6:19	6:20	6:23	6:24	6:26	6:29	6:32	6:35	6:37		**14**
1	010		6:00	6:03	6:06	6:08	6:11	6:14	6:17	6:21	6:24	6:26	6:27	6:28	6:31	6:32	6:34	6:37	6:40	6:43	6:45		**1**
9	012		6:07	6:10	6:13	6:15	6:18	6:21	6:24	6:28	6:31	6:33	6:34	6:35	6:38	6:39	6:41	6:44	6:47	6:50	6:52		**9**
3	014		6:14	6:17	6:20	6:22	6:25	6:28	6:31	6:35	6:38	6:40	6:41	6:42	6:45	6:46	6:48	6:51	6:54	6:57	6:59		**3**
11	016		6:21	6:24	6:27	6:29	6:32	6:35	6:38	6:42	6:45	6:47	6:48	6:49	6:52	6:53	6:55	6:58	7:01	7:04	7:06		**11**
5	018		6:28	6:31	6:34	6:36	6:39	6:42	6:45	6:49	6:52	6:54	6:55	6:56	6:59	7:00	7:02	7:05	7:08	7:11	7:13		**5**
13	020		6:35	6:38	6:41	6:43	6:46	6:49	6:52	6:56	6:59	7:01	7:02	7:03	7:06	7:07	7:09	7:12	7:15	7:18	7:20		**13**
7	022		6:42	6:45	6:48	6:50	6:53	6:56	6:59	7:03	7:06	7:08	7:09	7:10	7:13	7:14	7:16	7:19	7:22	7:25	7:27		**7**
15	024		6:49	6:52	6:55	6:57	7:00	7:03	7:06	7:10	7:13	7:15	7:16	7:17	7:20	7:21	7:23	7:26	7:29	7:32	7:34		**15**
2	026		6:56	6:59	7:02	7:04	7:07	7:10	7:13	7:17	7:20	7:22	7:23	7:24	7:27	7:28	7:30	7:33	7:36	7:39	7:41		**2**
4	028		7:03	7:06	7:09	7:11	7:14	7:17	7:20	7:24	7:27	7:29	7:30	7:31	7:34	7:35	7:37	7:40	7:43	7:46	7:48		**4**
10	030		7:10	7:13	7:16	7:18	7:21	7:24	7:27	7:31	7:34	7:36	7:37	7:38	7:41	7:42	7:44	7:47	7:50	7:53	7:55		**10**
6	032		7:17	7:20	7:23	7:25	7:28	7:31	7:34	7:38	7:41	7:43	7:44	7:45	7:48	7:49	7:51	7:54	7:57	8:00	8:02		**6**
12	034		7:24	7:27	7:30	7:32	7:35	7:38	7:41	7:45	7:48	7:50	7:51	7:52	7:55	7:56	7:58	8:01	8:04	8:07	8:09		**12**
8	036		7:31	7:34	7:37	7:39	7:42	7:45	7:48	7:52	7:55	7:57	7:58	7:59	8:02	8:03	8:05	8:08	8:11	8:14	8:16		**8**
14	038		7:38	7:41	7:44	7:46	7:49	7:52	7:55	7:59	8:02	8:04	8:05	8:06	8:09	8:10	8:12	8:15	8:18	8:21	8:23		**14**
1	040		7:45	7:48	7:51	7:53	7:56	7:59	8:02	8:06	8:09	8:11	8:12	8:13	8:16	8:17	8:19	8:22	8:25	8:28	8:30		**1**
9	042		7:52	7:55	7:58	8:00	8:03	8:06	8:09	8:13	8:16	8:18	8:19	8:20	8:23	8:24	8:26	8:29	8:32	8:35	8:37		**9**
3	044		7:59	8:02	8:05	8:07	8:10	8:13	8:16	8:20	8:23	8:25	8:26	8:27	8:30	8:31	8:33	8:36	8:39	8:42	8:44		**3**
11	046		8:06	8:09	8:12	8:14	8:17	8:20	8:23	8:27	8:30	8:32	8:33	8:34	8:37	8:38	8:40	8:43	8:46	8:49	8:51		**11**
5	048		8:13	8:16	8:19	8:21	8:24	8:27	8:30	8:34	8:37	8:39	8:40	8:41	8:44	8:45	8:47	8:50	8:53	8:56	8:58		**5**
13	050		8:20	8:23	8:26	8:28	8:31	8:34	8:37	8:41	8:44	8:46	8:47	8:48	8:51	8:52	8:54	8:57	9:00	9:03	9:05		**13**
7	052		8:27	8:30	8:33	8:35	8:38	8:41	8:44	8:48	8:51	8:53	8:54	8:55	8:58	8:59	9:01	9:04	9:07	9:10	9:12		**7**

Equipment set #		Yard Pull-out	CMS	Security Square	S.S. Administration	I-70 Park-and-Ride	Edmondson Village	Allendale EB	Rosemont	EB MARC Sta	Harlem Park	Poppleton	Howard St/ University Center	Inner Harbor	Harbor East	Fell's Point	Canton	Canton Crossing	Highlandtown	Bayview Campus	Bayview MARC	Yard Pull-in	Equipment set #
15	054		8:34	8:37	8:40	8:42	8:45	8:48	8:51	8:55	8:58	9:00	9:01	9:02	9:05	9:06	9:08	9:11	9:14	9:17	9:19		**15**
2	056		8:41	8:44	8:47	8:49	8:52	8:55	8:58	9:02	9:05	9:07	9:08	9:09	9:12	9:13	9:15	9:18	9:21	9:24	9:26		**2**
4	058		8:48	8:51	8:54	8:56	8:59	9:02	9:05	9:09	9:12	9:14	9:15	9:16	9:19	9:20	9:22	9:25	9:28	9:31	9:33		**4**
10	060		8:55	8:58	9:01	9:03	9:06	9:09	9:12	9:16	9:19	9:21	9:22	9:23	9:26	9:27	9:29	9:32	9:35	9:38	9:40		**10**
6	062		9:05	9:08	9:11	9:13	9:16	9:19	9:22	9:26	9:29	9:31	9:32	9:33	9:36	9:37	9:39	9:42	9:45	9:48	9:50		**6**
12	064		9:15	9:18	9:21	9:23	9:26	9:29	9:32	9:36	9:39	9:41	9:42	9:43	9:46	9:47	9:49	9:52	9:55	9:58	10:00		**12**
8	Y049		9:20	9:23	9:26	9:28	9:31	9:34	9:37													9:38	**8**
14	066		9:25	9:28	9:31	9:33	9:36	9:39	9:42	9:46	9:49	9:51	9:52	9:53	9:56	9:57	9:59	10:02	10:05	10:08	10:10		**14**
1	068		9:35	9:38	9:41	9:43	9:46	9:49	9:52	9:56	9:59	10:01	10:02	10:03	10:06	10:07	10:09	10:12	10:15	10:18	10:20		**1**
9	Y055		9:40	9:43	9:46	9:48	9:51	9:54	9:57													9:58	**9**
3	070		9:45	9:48	9:51	9:53	9:56	9:59	10:02	10:06	10:09	10:11	10:12	10:13	10:16	10:17	10:19	10:22	10:25	10:28	10:30		**3**
11	072		9:55	9:58	10:01	10:03	10:06	10:09	10:12	10:16	10:19	10:21	10:22	10:23	10:26	10:27	10:29	10:32	10:35	10:38	10:40		**11**
5	074		10:05	10:08	10:11	10:13	10:16	10:19	10:22	10:26	10:29	10:31	10:32	10:33	10:36	10:37	10:39	10:42	10:45	10:48	10:50		**5**
7	076		10:15	10:18	10:21	10:23	10:26	10:29	10:32	10:36	10:39	10:41	10:42	10:43	10:46	10:47	10:49	10:52	10:55	10:58	11:00		**7**
15	078		10:25	10:28	10:31	10:33	10:36	10:39	10:42	10:46	10:49	10:51	10:52	10:53	10:56	10:57	10:59	11:02	11:05	11:08	11:10		**15**
4	080		10:35	10:38	10:41	10:43	10:46	10:49	10:52	10:56	10:59	11:01	11:02	11:03	11:06	11:07	11:09	11:12	11:15	11:18	11:20		**4**
10	082		10:45	10:48	10:51	10:53	10:56	10:59	11:02	11:06	11:09	11:11	11:12	11:13	11:16	11:17	11:19	11:22	11:25	11:28	11:30		**10**
6	084		10:55	10:58	11:01	11:03	11:06	11:09	11:12	11:16	11:19	11:21	11:22	11:23	11:26	11:27	11:29	11:32	11:35	11:38	11:40		**6**
12	086		11:05	11:08	11:11	11:13	11:16	11:19	11:22	11:26	11:29	11:31	11:32	11:33	11:36	11:37	11:39	11:42	11:45	11:48	11:50		**12**
14	088		11:15	11:18	11:21	11:23	11:26	11:29	11:32	11:36	11:39	11:41	11:42	11:43	11:46	11:47	11:49	11:52	11:55	11:58	12:00		**14**
1	090		11:25	11:28	11:31	11:33	11:36	11:39	11:42	11:46	11:49	11:51	11:52	11:53	11:56	11:57	11:59	12:02	12:05	12:08	12:10		**1**
3	092		11:35	11:38	11:41	11:43	11:46	11:49	11:52	11:56	11:59	12:01	12:02	12:03	12:06	12:07	12:09	12:12	12:15	12:18	12:20		**3**
11	094		11:45	11:48	11:51	11:53	11:56	11:59	12:02	12:06	12:09	12:11	12:12	12:13	12:16	12:17	12:19	12:22	12:25	12:28	12:30		**11**
5	096		11:55	11:58	12:01	12:03	12:06	12:09	12:12	12:16	12:19	12:21	12:22	12:23	12:26	12:27	12:29	12:32	12:35	12:38	12:40		**5**
7	098		12:05	12:08	12:11	12:13	12:16	12:19	12:22	12:26	12:29	12:31	12:32	12:33	12:36	12:37	12:39	12:42	12:45	12:48	12:50		**7**
15	100		12:15	12:18	12:21	12:23	12:26	12:29	12:32	12:36	12:39	12:41	12:42	12:43	12:46	12:47	12:49	12:52	12:55	12:58	13:00		**15**
4	102		12:25	12:28	12:31	12:33	12:36	12:39	12:42	12:46	12:49	12:51	12:52	12:53	12:56	12:57	12:59	13:02	13:05	13:08	13:10		**4**
10	104		12:35	12:38	12:41	12:43	12:46	12:49	12:52	12:56	12:59	13:01	13:02	13:03	13:06	13:07	13:09	13:12	13:15	13:18	13:20		**10**
6	106		12:45	12:48	12:51	12:53	12:56	12:59	13:02	13:06	13:09	13:11	13:12	13:13	13:16	13:17	13:19	13:22	13:25	13:28	13:30		**6**
12	108		12:55	12:58	13:01	13:03	13:06	13:09	13:12	13:16	13:19	13:21	13:22	13:23	13:26	13:27	13:29	13:32	13:35	13:38	13:40		**12**
14	110		13:05	13:08	13:11	13:13	13:16	13:19	13:22	13:26	13:29	13:31	13:32	13:33	13:36	13:37	13:39	13:42	13:45	13:48	13:50		**14**
1	112		13:15	13:18	13:21	13:23	13:26	13:29	13:32	13:36	13:39	13:41	13:42	13:43	13:46	13:47	13:49	13:52	13:55	13:58	14:00		**1**
3	114		13:25	13:28	13:31	13:33	13:36	13:39	13:42	13:46	13:49	13:51	13:52	13:53	13:56	13:57	13:59	14:02	14:05	14:08	14:10		**3**
11	116		13:35	13:38	13:41	13:43	13:46	13:49	13:52	13:56	13:59	14:01	14:02	14:03	14:06	14:07	14:09	14:12	14:15	14:18	14:20		**11**

Equipment set #		Yard Pull-out	CMS	Security Square	S.S. Administration	I-70 Park-and-Ride	Edmondson Village	Allendale EB	Rosemont	EB MARC Sta	Harlem Park	Poppleton	Howard St/ University Center	Inner Harbor	Harbor East	Fell's Point	Canton	Canton Crossing	Highlandtown	Bayview Campus	Bayview MARC	Yard Pull-in	Equipment set #
5	118		13:45	13:48	13:51	13:53	13:56	13:59	14:02	14:06	14:09	14:11	14:12	14:13	14:16	14:17	14:19	14:22	14:25	14:28	14:30		**5**
7	120		13:55	13:58	14:01	14:03	14:06	14:09	14:12	14:16	14:19	14:21	14:22	14:23	14:26	14:27	14:29	14:32	14:35	14:38	14:40		**7**
15	122		14:05	14:08	14:11	14:13	14:16	14:19	14:22	14:26	14:29	14:31	14:32	14:33	14:36	14:37	14:39	14:42	14:45	14:48	14:50		**15**
4	124		14:15	14:18	14:21	14:23	14:26	14:29	14:32	14:36	14:39	14:41	14:42	14:43	14:46	14:47	14:49	14:52	14:55	14:58	15:00		**4**
10	126		14:25	14:28	14:31	14:33	14:36	14:39	14:42	14:46	14:49	14:51	14:52	14:53	14:56	14:57	14:59	15:02	15:05	15:08	15:10		**10**
6	128		14:35	14:38	14:41	14:43	14:46	14:49	14:52	14:56	14:59	15:01	15:02	15:03	15:06	15:07	15:09	15:12	15:15	15:18	15:20		**6**
12	130		14:45	14:48	14:51	14:53	14:56	14:59	15:02	15:06	15:09	15:11	15:12	15:13	15:16	15:17	15:19	15:22	15:25	15:28	15:30		**12**
8	Y141	15:11								15:13	15:16	15:18	15:19	15:20	15:23	15:24	15:26	15:29	15:32	15:35	15:37		**8**
14	132		14:55	14:58	15:01	15:03	15:06	15:09	15:12	15:16	15:19	15:21	15:22	15:23	15:26	15:27	15:29	15:32	15:35	15:38	15:40		**14**
1	134		15:05	15:08	15:11	15:13	15:16	15:19	15:22	15:26	15:29	15:31	15:32	15:33	15:36	15:37	15:39	15:42	15:45	15:48	15:50		**1**
9	Y147	15:31								15:33	15:36	15:38	15:39	15:40	15:43	15:44	15:46	15:49	15:52	15:55	15:57		**9**
3	136		15:15	15:18	15:21	15:23	15:26	15:29	15:32	15:36	15:39	15:41	15:42	15:43	15:46	15:47	15:49	15:52	15:55	15:58	16:00		**3**
11	138		15:25	15:28	15:31	15:33	15:36	15:39	15:42	15:46	15:49	15:51	15:52	15:53	15:56	15:57	15:59	16:02	16:05	16:08	16:10		**11**
5	140		15:32	15:35	15:38	15:40	15:43	15:46	15:49	15:53	15:56	15:58	15:59	16:00	16:03	16:04	16:06	16:09	16:12	16:15	16:17		**5**
13	142		15:39	15:42	15:45	15:47	15:50	15:53	15:56	16:00	16:03	16:05	16:06	16:07	16:10	16:11	16:13	16:16	16:19	16:22	16:24		**13**
7	144		15:46	15:49	15:52	15:54	15:57	16:00	16:03	16:07	16:10	16:12	16:13	16:14	16:17	16:18	16:20	16:23	16:26	16:29	16:31		**7**
15	146		15:53	15:56	15:59	16:01	16:04	16:07	16:10	16:14	16:17	16:19	16:20	16:21	16:24	16:25	16:27	16:30	16:33	16:36	16:38		**15**
2	148		16:00	16:03	16:06	16:08	16:11	16:14	16:17	16:21	16:24	16:26	16:27	16:28	16:31	16:32	16:34	16:37	16:40	16:43	16:45		**2**
4	150		16:07	16:10	16:13	16:15	16:18	16:21	16:24	16:28	16:31	16:33	16:34	16:35	16:38	16:39	16:41	16:44	16:47	16:50	16:52		**4**
10	152		16:14	16:17	16:20	16:22	16:25	16:28	16:31	16:35	16:38	16:40	16:41	16:42	16:45	16:46	16:48	16:51	16:54	16:57	16:59		**10**
6	154		16:21	16:24	16:27	16:29	16:32	16:35	16:38	16:42	16:45	16:47	16:48	16:49	16:52	16:53	16:55	16:58	17:01	17:04	17:06		**6**
12	156		16:28	16:31	16:34	16:36	16:39	16:42	16:45	16:49	16:52	16:54	16:55	16:56	16:59	17:00	17:02	17:05	17:08	17:11	17:13		**12**
8	158		16:35	16:38	16:41	16:43	16:46	16:49	16:52	16:56	16:59	17:01	17:02	17:03	17:06	17:07	17:09	17:12	17:15	17:18	17:20		**8**
14	160		16:42	16:45	16:48	16:50	16:53	16:56	16:59	17:03	17:06	17:08	17:09	17:10	17:13	17:14	17:16	17:19	17:22	17:25	17:27		**14**
1	162		16:49	16:52	16:55	16:57	17:00	17:03	17:06	17:10	17:13	17:15	17:16	17:17	17:20	17:21	17:23	17:26	17:29	17:32	17:34		**1**
9	164		16:56	16:59	17:02	17:04	17:07	17:10	17:13	17:17	17:20	17:22	17:23	17:24	17:27	17:28	17:30	17:33	17:36	17:39	17:41		**9**
3	166		17:03	17:06	17:09	17:11	17:14	17:17	17:20	17:24	17:27	17:29	17:30	17:31	17:34	17:35	17:37	17:40	17:43	17:46	17:48		**3**
11	168		17:10	17:13	17:16	17:18	17:21	17:24	17:27	17:31	17:34	17:36	17:37	17:38	17:41	17:42	17:44	17:47	17:50	17:53	17:55		**11**
5	170		17:17	17:20	17:23	17:25	17:28	17:31	17:34	17:38	17:41	17:43	17:44	17:45	17:48	17:49	17:51	17:54	17:57	18:00	18:02		**5**
13	172		17:24	17:27	17:30	17:32	17:35	17:38	17:41	17:45	17:48	17:50	17:51	17:52	17:55	17:56	17:58	18:01	18:04	18:07	18:09		**13**
7	174		17:31	17:34	17:37	17:39	17:42	17:45	17:48	17:52	17:55	17:57	17:58	17:59	18:02	18:03	18:05	18:08	18:11	18:14	18:16		**7**
15	176		17:38	17:41	17:44	17:46	17:49	17:52	17:55	17:59	18:02	18:04	18:05	18:06	18:09	18:10	18:12	18:15	18:18	18:21	18:23		**15**
2	178		17:45	17:48	17:51	17:53	17:56	17:59	18:02	18:06	18:09	18:11	18:12	18:13	18:16	18:17	18:19	18:22	18:25	18:28	18:30		**2**
4	180		17:52	17:55	17:58	18:00	18:03	18:06	18:09	18:13	18:16	18:18	18:19	18:20	18:23	18:24	18:26	18:29	18:32	18:35	18:37		**4**

Equipment set #		Yard Pull-out	CMS	Security Square	S.S. Administration	I-70 Park-and-Ride	Edmondson Village	Allendale EB	Rosemont	EB MARC Sta	Harlem Park	Poppleton	Howard St/ University Center	Inner Harbor	Harbor East	Fell's Point	Canton	Canton Crossing	Highlandtown	Bayview Campus	Bayview MARC	Yard Pull-in	Equipment set #
10	182		17:59	18:02	18:05	18:07	18:10	18:13	18:16	18:20	18:23	18:25	18:26	18:27	18:30	18:31	18:33	18:36	18:39	18:42	18:44		**10**
6	184		18:06	18:09	18:12	18:14	18:17	18:20	18:23	18:27	18:30	18:32	18:33	18:34	18:37	18:38	18:40	18:43	18:46	18:49	18:51		**6**
12	186		18:13	18:16	18:19	18:21	18:24	18:27	18:30	18:34	18:37	18:39	18:40	18:41	18:44	18:45	18:47	18:50	18:53	18:56	18:58		**12**
8	188		18:20	18:23	18:26	18:28	18:31	18:34	18:37	18:41	18:44	18:46	18:47	18:48	18:51	18:52	18:54	18:57	19:00	19:03	19:05		**8**
14	190		18:27	18:30	18:33	18:35	18:38	18:41	18:44	18:48	18:51	18:53	18:54	18:55	18:58	18:59	19:01	19:04	19:07	19:10	19:12		**14**
1	192		18:35	18:38	18:41	18:43	18:46	18:49	18:52	18:56	18:59	19:01	19:02	19:03	19:06	19:07	19:09	19:12	19:15	19:18	19:20		**1**
9	194		18:45	18:48	18:51	18:53	18:56	18:59	19:02	19:06	19:09	19:11	19:12	19:13	19:16	19:17	19:19	19:22	19:25	19:28	19:30		**9**
3	196		18:55	18:58	19:01	19:03	19:06	19:09	19:12	19:16	19:19	19:21	19:22	19:23	19:26	19:27	19:29	19:32	19:35	19:38	19:40		**3**
11	Y181		19:00	19:03	19:06	19:08	19:11	19:14	19:17													19:18	**11**
5	198		19:05	19:08	19:11	19:13	19:16	19:19	19:22	19:26	19:29	19:31	19:32	19:33	19:36	19:37	19:39	19:42	19:45	19:48	19:50		**5**
13	200		19:15	19:18	19:21	19:23	19:26	19:29	19:32	19:36	19:39	19:41	19:42	19:43	19:46	19:47	19:49	19:52	19:55	19:58	20:00		**13**
7	Y187		19:20	19:23	19:26	19:28	19:31	19:34	19:37													19:38	**7**
15	202		19:25	19:28	19:31	19:33	19:36	19:39	19:42	19:46	19:49	19:51	19:52	19:53	19:56	19:57	19:59	20:02	20:05	20:08	20:10		**15**
2	204		19:35	19:38	19:41	19:43	19:46	19:49	19:52	19:56	19:59	20:01	20:02	20:03	20:06	20:07	20:09	20:12	20:15	20:18	20:20		**2**
10	206		19:45	19:48	19:51	19:53	19:56	19:59	20:02	20:06	20:09	20:11	20:12	20:13	20:16	20:17	20:19	20:22	20:25	20:28	20:30		**10**
6	208		19:55	19:58	20:01	20:03	20:06	20:09	20:12	20:16	20:19	20:21	20:22	20:23	20:26	20:27	20:29	20:32	20:35	20:38	20:40		**6**
12	210		20:05	20:08	20:11	20:13	20:16	20:19	20:22	20:26	20:29	20:31	20:32	20:33	20:36	20:37	20:39	20:42	20:45	20:48	20:50		**12**
14	212		20:15	20:18	20:21	20:23	20:26	20:29	20:32	20:36	20:39	20:41	20:42	20:43	20:46	20:47	20:49	20:52	20:55	20:58	21:00		**14**
1	214		20:25	20:28	20:31	20:33	20:36	20:39	20:42	20:46	20:49	20:51	20:52	20:53	20:56	20:57	20:59	21:02	21:05	21:08	21:10		**1**
9	216		20:35	20:38	20:41	20:43	20:46	20:49	20:52	20:56	20:59	21:01	21:02	21:03	21:06	21:07	21:09	21:12	21:15	21:18	21:20		**9**
3	218		20:45	20:48	20:51	20:53	20:56	20:59	21:02	21:06	21:09	21:11	21:12	21:13	21:16	21:17	21:19	21:22	21:25	21:28	21:30		**3**
5	220		20:55	20:58	21:01	21:03	21:06	21:09	21:12	21:16	21:19	21:21	21:22	21:23	21:26	21:27	21:29	21:32	21:35	21:38	21:40		**5**
13	222		21:05	21:08	21:11	21:13	21:16	21:19	21:22	21:26	21:29	21:31	21:32	21:33	21:36	21:37	21:39	21:42	21:45	21:48	21:50		**13**
15	224		21:20	21:23	21:26	21:28	21:31	21:34	21:37	21:41	21:44	21:46	21:47	21:48	21:51	21:52	21:54	21:57	22:00	22:03	22:05		**15**
2	Y213		21:25	21:28	21:31	21:33	21:36	21:39	21:42													21:43	**2**
10	226		21:35	21:38	21:41	21:43	21:46	21:49	21:52	21:56	21:59	22:01	22:02	22:03	22:06	22:07	22:09	22:12	22:15	22:18	22:20		**10**
6	228		21:50	21:53	21:56	21:58	22:01	22:04	22:07	22:11	22:14	22:16	22:17	22:18	22:21	22:22	22:24	22:27	22:30	22:33	22:35		**6**
12	230		22:05	22:08	22:11	22:13	22:16	22:19	22:22	22:26	22:29	22:31	22:32	22:33	22:36	22:37	22:39	22:42	22:45	22:48	22:50		**12**
14	232		22:20	22:23	22:26	22:28	22:31	22:34	22:37	22:41	22:44	22:46	22:47	22:48	22:51	22:52	22:54	22:57	23:00	23:03	23:05		**14**
9	234		22:35	22:38	22:41	22:43	22:46	22:49	22:52	22:56	22:59	23:01	23:02	23:03	23:06	23:07	23:09	23:12	23:15	23:18	23:20		**9**
3	236		22:50	22:53	22:56	22:58	23:01	23:04	23:07	23:11	23:14	23:16	23:17	23:18	23:21	23:22	23:24	23:27	23:30	23:33	23:35		**3**
13	238		23:05	23:08	23:11	23:13	23:16	23:19	23:22	23:26	23:29	23:31	23:32	23:33	23:36	23:37	23:39	23:42	23:45	23:48	23:50		**13**
15	240		23:20	23:23	23:26	23:28	23:31	23:34	23:37	23:41	23:44	23:46	23:47	23:48	23:51	23:52	23:54	23:57	0:00	0:03	0:05		**15**
10	242		23:35	23:38	23:41	23:43	23:46	23:49	23:52	23:56	23:59	0:01	0:02	0:03	0:06	0:07	0:09	0:12	0:15	0:18	0:20		**10**

Equipment set #		Yard Pull-out	CMS	Security Square	S.S. Administration	I-70 Park-and-Ride	Edmondson Village	Allendale EB	Rosemont	EB MARC Sta	Harlem Park	Poppleton	Howard St/ University Center	Inner Harbor	Harbor East	Fell's Point	Canton	Canton Crossing	Highlandtown	Bayview Campus	Bayview MARC	Yard Pull-in	Equipment set #
6	244		23:50	23:53	23:56	23:58	0:01	0:04	0:07	0:11	0:14	0:16	0:17	0:18	0:21	0:22	0:24	0:27	0:30	0:33	0:35		**6**
12	246		0:05	0:08	0:11	0:13	0:16	0:19	0:22	0:26	0:29	0:31	0:32	0:33	0:36	0:37	0:39	0:42	0:45	0:48	0:50		**12**
14	248		0:20	0:23	0:26	0:28	0:31	0:34	0:37	0:41	0:44	0:46	0:47	0:48	0:51	0:52	0:54	0:57	1:00	1:03	1:05		**14**
9	250		0:35	0:38	0:41	0:43	0:46	0:49	0:52	0:56	0:59	1:01	1:02	1:03	1:06	1:07	1:09	1:12	1:15	1:18	1:20		**9**
3	252		0:50	0:53	0:56	0:58	1:01	1:04	1:07	1:11	1:14	1:16	1:17	1:18	1:21	1:22	1:24	1:27	1:30	1:33	1:35		**3**
13	254		1:05	1:08	1:11	1:13	1:16	1:19	1:22	1:26	1:29	1:31	1:32	1:33	1:36	1:37	1:39	1:42	1:45	1:48	1:50		**13**
15	Y245		1:20	1:23	1:26	1:28	1:31	1:34	1:37													1:38	**15**
10	Y247		1:35	1:38	1:41	1:43	1:46	1:49	1:52													1:53	**10**
6	Y249		1:50	1:53	1:56	1:58	2:01	2:04	2:07													2:08	**6**
12	Y251		2:05	2:08	2:11	2:13	2:16	2:19	2:22													2:23	**12**

Appendix J
2035 Operating Plan – Westbound

Equipment set #		Yard Pull-out	Bayview MARC	Bayview Campus	Highlandtown	Canton Crossing	Canton	Fell's Point	Harbor East	Inner Harbor	Howard St/ University Center	Poppleton	Harlem Park	EB MARC Station	Rosemont	Allendale EB	Edmondson Village	I-70 Park-and-Ride	S.S. Administration	Security Square	CMS	Yard Pull-in	Equipment set #
2	Y002	4:31													4:32	4:36	4:38	4:42	4:44	4:46	4:50		**2**
4	Y004	4:46													4:47	4:51	4:53	4:57	4:59	5:01	5:05		**4**
6	Y006	5:01													5:02	5:06	5:08	5:12	5:14	5:16	5:20		**6**
8	Y008	5:16													5:17	5:21	5:23	5:27	5:29	5:31	5:35		**8**
1	001		5:05	5:07	5:09	5:12	5:16	5:18	5:19	5:21	5:22	5:24	5:26	5:29	5:32	5:36	5:38	5:42	5:44	5:46	5:50		**1**
9	Y012	5:38													5:39	5:43	5:45	5:49	5:51	5:53	5:57		**9**
3	003		5:20	5:22	5:24	5:27	5:31	5:33	5:34	5:36	5:37	5:39	5:41	5:44	5:47	5:51	5:53	5:57	5:59	6:01	6:05		**3**
11	Y016	5:53													5:54	5:58	6:00	6:04	6:06	6:08	6:12		**11**
5	005		5:35	5:37	5:39	5:42	5:46	5:48	5:49	5:51	5:52	5:54	5:56	5:59	6:02	6:06	6:08	6:12	6:14	6:16	6:20		**5**
13	Y020	6:08													6:09	6:13	6:15	6:19	6:21	6:23	6:27		**13**
7	007		5:50	5:52	5:54	5:57	6:01	6:03	6:04	6:06	6:07	6:09	6:11	6:14	6:17	6:21	6:23	6:27	6:29	6:31	6:35		**7**
15	Y024	6:23													6:24	6:28	6:30	6:34	6:36	6:38	6:42		**15**
2	009		6:05	6:07	6:09	6:12	6:16	6:18	6:19	6:21	6:22	6:24	6:26	6:29	6:32	6:36	6:38	6:42	6:44	6:46	6:50		**2**
4	011		6:12	6:14	6:16	6:19	6:23	6:25	6:26	6:28	6:29	6:31	6:33	6:36	6:39	6:43	6:45	6:49	6:51	6:53	6:57		**4**
10	013		6:19	6:21	6:23	6:26	6:30	6:32	6:33	6:35	6:36	6:38	6:40	6:43	6:46	6:50	6:52	6:56	6:58	7:00	7:04		**10**
6	015		6:26	6:28	6:30	6:33	6:37	6:39	6:40	6:42	6:43	6:45	6:47	6:50	6:53	6:57	6:59	7:03	7:05	7:07	7:11		**6**
12	017		6:33	6:35	6:37	6:40	6:44	6:46	6:47	6:49	6:50	6:52	6:54	6:57	7:00	7:04	7:06	7:10	7:12	7:14	7:18		**12**
8	019		6:40	6:42	6:44	6:47	6:51	6:53	6:54	6:56	6:57	6:59	7:01	7:04	7:07	7:11	7:13	7:17	7:19	7:21	7:25		**8**
14	021		6:47	6:49	6:51	6:54	6:58	7:00	7:01	7:03	7:04	7:06	7:08	7:11	7:14	7:18	7:20	7:24	7:26	7:28	7:32		**14**
1	023		6:54	6:56	6:58	7:01	7:05	7:07	7:08	7:10	7:11	7:13	7:15	7:18	7:21	7:25	7:27	7:31	7:33	7:35	7:39		**1**
9	025		7:01	7:03	7:05	7:08	7:12	7:14	7:15	7:17	7:18	7:20	7:22	7:25	7:28	7:32	7:34	7:38	7:40	7:42	7:46		**9**
3	027		7:08	7:10	7:12	7:15	7:19	7:21	7:22	7:24	7:25	7:27	7:29	7:32	7:35	7:39	7:41	7:45	7:47	7:49	7:53		**3**
11	029		7:15	7:17	7:19	7:22	7:26	7:28	7:29	7:31	7:32	7:34	7:36	7:39	7:42	7:46	7:48	7:52	7:54	7:56	8:00		**11**
5	031		7:22	7:24	7:26	7:29	7:33	7:35	7:36	7:38	7:39	7:41	7:43	7:46	7:49	7:53	7:55	7:59	8:01	8:03	8:07		**5**
13	033		7:29	7:31	7:33	7:36	7:40	7:42	7:43	7:45	7:46	7:48	7:50	7:53	7:56	8:00	8:02	8:06	8:08	8:10	8:14		**13**
7	035		7:36	7:38	7:40	7:43	7:47	7:49	7:50	7:52	7:53	7:55	7:57	8:00	8:03	8:07	8:09	8:13	8:15	8:17	8:21		**7**
15	037		7:43	7:45	7:47	7:50	7:54	7:56	7:57	7:59	8:00	8:02	8:04	8:07	8:10	8:14	8:16	8:20	8:22	8:24	8:28		**15**
2	039		7:50	7:52	7:54	7:57	8:01	8:03	8:04	8:06	8:07	8:09	8:11	8:14	8:17	8:21	8:23	8:27	8:29	8:31	8:35		**2**
4	041		7:57	7:59	8:01	8:04	8:08	8:10	8:11	8:13	8:14	8:16	8:18	8:21	8:24	8:28	8:30	8:34	8:36	8:38	8:42		**4**
10	043		8:04	8:06	8:08	8:11	8:15	8:17	8:18	8:20	8:21	8:23	8:25	8:28	8:31	8:35	8:37	8:41	8:43	8:45	8:49		**10**
6	045		8:11	8:13	8:15	8:18	8:22	8:24	8:25	8:27	8:28	8:30	8:32	8:35	8:38	8:42	8:44	8:48	8:50	8:52	8:56		**6**
12	047		8:18	8:20	8:22	8:25	8:29	8:31	8:32	8:34	8:35	8:37	8:39	8:42	8:45	8:49	8:51	8:55	8:57	8:59	9:03		**12**
8	049		8:25	8:27	8:29	8:32	8:36	8:38	8:39	8:41	8:42	8:44	8:46	8:49	8:52	8:56	8:58	9:02	9:04	9:06	9:10		**8**

Equipment set #		Yard Pull-out	Bayview MARC	Bayview Campus	Highlandtown	Canton Crossing	Canton	Fell's Point	Harbor East	Inner Harbor	Howard St/ University Center	Poppleton	Harlem Park	EB MARC Station	Rosemont	Allendale EB	Edmondson Village	I-70 Park-and-Ride	S.S. Administration	Security Square	CMS	Yard Pull-in	Equipment set #
14	051		8:32	8:34	8:36	8:39	8:43	8:45	8:46	8:48	8:49	8:51	8:53	8:56	8:59	9:03	9:05	9:09	9:11	9:13	9:17		**14**
1	053		8:39	8:41	8:43	8:46	8:50	8:52	8:53	8:55	8:56	8:58	9:00	9:03	9:06	9:10	9:12	9:16	9:18	9:20	9:24		**1**
9	055		8:46	8:48	8:50	8:53	8:57	8:59	9:00	9:02	9:03	9:05	9:07	9:10	9:13	9:17	9:19	9:23	9:25	9:27	9:31		**9**
3	057		8:53	8:55	8:57	9:00	9:04	9:06	9:07	9:09	9:10	9:12	9:14	9:17	9:20	9:24	9:26	9:30	9:32	9:34	9:38		**3**
11	059		9:00	9:02	9:04	9:07	9:11	9:13	9:14	9:16	9:17	9:19	9:21	9:24	9:27	9:31	9:33	9:37	9:39	9:41	9:45		**11**
5	061		9:10	9:12	9:14	9:17	9:21	9:23	9:24	9:26	9:27	9:29	9:31	9:34	9:37	9:41	9:43	9:47	9:49	9:51	9:55		**5**
13	Y050		9:15	9:17	9:19	9:22	9:26	9:28	9:29	9:31	9:32	9:34	9:36	9:39								9:40	**13**
7	063		9:20	9:22	9:24	9:27	9:31	9:33	9:34	9:36	9:37	9:39	9:41	9:44	9:47	9:51	9:53	9:57	9:59	10:01	10:05		**7**
15	065		9:30	9:32	9:34	9:37	9:41	9:43	9:44	9:46	9:47	9:49	9:51	9:54	9:57	10:01	10:03	10:07	10:09	10:11	10:15		**15**
2	Y056		9:35	9:37	9:39	9:42	9:46	9:48	9:49	9:51	9:52	9:54	9:56	9:59								10:00	**2**
4	067		9:40	9:42	9:44	9:47	9:51	9:53	9:54	9:56	9:57	9:59	10:01	10:04	10:07	10:11	10:13	10:17	10:19	10:21	10:25		**4**
10	069		9:50	9:52	9:54	9:57	10:01	10:03	10:04	10:06	10:07	10:09	10:11	10:14	10:17	10:21	10:23	10:27	10:29	10:31	10:35		**10**
6	071		10:00	10:02	10:04	10:07	10:11	10:13	10:14	10:16	10:17	10:19	10:21	10:24	10:27	10:31	10:33	10:37	10:39	10:41	10:45		**6**
12	073		10:10	10:12	10:14	10:17	10:21	10:23	10:24	10:26	10:27	10:29	10:31	10:34	10:37	10:41	10:43	10:47	10:49	10:51	10:55		**12**
14	075		10:20	10:22	10:24	10:27	10:31	10:33	10:34	10:36	10:37	10:39	10:41	10:44	10:47	10:51	10:53	10:57	10:59	11:01	11:05		**14**
1	077		10:30	10:32	10:34	10:37	10:41	10:43	10:44	10:46	10:47	10:49	10:51	10:54	10:57	11:01	11:03	11:07	11:09	11:11	11:15		**1**
3	079		10:40	10:42	10:44	10:47	10:51	10:53	10:54	10:56	10:57	10:59	11:01	11:04	11:07	11:11	11:13	11:17	11:19	11:21	11:25		**3**
11	081		10:50	10:52	10:54	10:57	11:01	11:03	11:04	11:06	11:07	11:09	11:11	11:14	11:17	11:21	11:23	11:27	11:29	11:31	11:35		**11**
5	083		11:00	11:02	11:04	11:07	11:11	11:13	11:14	11:16	11:17	11:19	11:21	11:24	11:27	11:31	11:33	11:37	11:39	11:41	11:45		**5**
7	085		11:10	11:12	11:14	11:17	11:21	11:23	11:24	11:26	11:27	11:29	11:31	11:34	11:37	11:41	11:43	11:47	11:49	11:51	11:55		**7**
15	087		11:20	11:22	11:24	11:27	11:31	11:33	11:34	11:36	11:37	11:39	11:41	11:44	11:47	11:51	11:53	11:57	11:59	12:01	12:05		**15**
4	089		11:30	11:32	11:34	11:37	11:41	11:43	11:44	11:46	11:47	11:49	11:51	11:54	11:57	12:01	12:03	12:07	12:09	12:11	12:15		**4**
10	091		11:40	11:42	11:44	11:47	11:51	11:53	11:54	11:56	11:57	11:59	12:01	12:04	12:07	12:11	12:13	12:17	12:19	12:21	12:25		**10**
6	093		11:50	11:52	11:54	11:57	12:01	12:03	12:04	12:06	12:07	12:09	12:11	12:14	12:17	12:21	12:23	12:27	12:29	12:31	12:35		**6**
12	095		12:00	12:02	12:04	12:07	12:11	12:13	12:14	12:16	12:17	12:19	12:21	12:24	12:27	12:31	12:33	12:37	12:39	12:41	12:45		**12**
14	097		12:10	12:12	12:14	12:17	12:21	12:23	12:24	12:26	12:27	12:29	12:31	12:34	12:37	12:41	12:43	12:47	12:49	12:51	12:55		**14**
1	099		12:20	12:22	12:24	12:27	12:31	12:33	12:34	12:36	12:37	12:39	12:41	12:44	12:47	12:51	12:53	12:57	12:59	13:01	13:05		**1**
3	101		12:30	12:32	12:34	12:37	12:41	12:43	12:44	12:46	12:47	12:49	12:51	12:54	12:57	13:01	13:03	13:07	13:09	13:11	13:15		**3**
11	103		12:40	12:42	12:44	12:47	12:51	12:53	12:54	12:56	12:57	12:59	13:01	13:04	13:07	13:11	13:13	13:17	13:19	13:21	13:25		**11**
5	105		12:50	12:52	12:54	12:57	13:01	13:03	13:04	13:06	13:07	13:09	13:11	13:14	13:17	13:21	13:23	13:27	13:29	13:31	13:35		**5**
7	107		13:00	13:02	13:04	13:07	13:11	13:13	13:14	13:16	13:17	13:19	13:21	13:24	13:27	13:31	13:33	13:37	13:39	13:41	13:45		**7**
15	109		13:10	13:12	13:14	13:17	13:21	13:23	13:24	13:26	13:27	13:29	13:31	13:34	13:37	13:41	13:43	13:47	13:49	13:51	13:55		**15**
4	111		13:20	13:22	13:24	13:27	13:31	13:33	13:34	13:36	13:37	13:39	13:41	13:44	13:47	13:51	13:53	13:57	13:59	14:01	14:05		**4**
10	113		13:30	13:32	13:34	13:37	13:41	13:43	13:44	13:46	13:47	13:49	13:51	13:54	13:57	14:01	14:03	14:07	14:09	14:11	14:15		**10**

Equipment set #		Yard Pull-out	Bayview MARC	Bayview Campus	Highlandtown	Canton Crossing	Canton	Fell's Point	Harbor East	Inner Harbor	Howard St/ University Center	Poppleton	Harlem Park	EB MARC Station	Rosemont	Allendale EB	Edmondson Village	I-70 Park-and-Ride	S.S. Administration	Security Square	CMS	Yard Pull-in	Equipment set #
6	115		13:40	13:42	13:44	13:47	13:51	13:53	13:54	13:56	13:57	13:59	14:01	14:04	14:07	14:11	14:13	14:17	14:19	14:21	14:25		**6**
12	117		13:50	13:52	13:54	13:57	14:01	14:03	14:04	14:06	14:07	14:09	14:11	14:14	14:17	14:21	14:23	14:27	14:29	14:31	14:35		**12**
14	119		14:00	14:02	14:04	14:07	14:11	14:13	14:14	14:16	14:17	14:19	14:21	14:24	14:27	14:31	14:33	14:37	14:39	14:41	14:45		**14**
1	121		14:10	14:12	14:14	14:17	14:21	14:23	14:24	14:26	14:27	14:29	14:31	14:34	14:37	14:41	14:43	14:47	14:49	14:51	14:55		**1**
3	123		14:20	14:22	14:24	14:27	14:31	14:33	14:34	14:36	14:37	14:39	14:41	14:44	14:47	14:51	14:53	14:57	14:59	15:01	15:05		**3**
11	125		14:30	14:32	14:34	14:37	14:41	14:43	14:44	14:46	14:47	14:49	14:51	14:54	14:57	15:01	15:03	15:07	15:09	15:11	15:15		**11**
5	127		14:40	14:42	14:44	14:47	14:51	14:53	14:54	14:56	14:57	14:59	15:01	15:04	15:07	15:11	15:13	15:17	15:19	15:21	15:25		**5**
13	Y142	15:13													15:14	15:18	15:20	15:24	15:26	15:28	15:32		**13**
7	129		14:50	14:52	14:54	14:57	15:01	15:03	15:04	15:06	15:07	15:09	15:11	15:14	15:17	15:21	15:23	15:27	15:29	15:31	15:35		**7**
15	131		15:00	15:02	15:04	15:07	15:11	15:13	15:14	15:16	15:17	15:19	15:21	15:24	15:27	15:31	15:33	15:37	15:39	15:41	15:45		**15**
2	Y148	15:31													15:32	15:36	15:38	15:42	15:44	15:46	15:50		**2**
4	133		15:10	15:12	15:14	15:17	15:21	15:23	15:24	15:26	15:27	15:29	15:31	15:34	15:37	15:41	15:43	15:47	15:49	15:51	15:55		**4**
10	135		15:20	15:22	15:24	15:27	15:31	15:33	15:34	15:36	15:37	15:39	15:41	15:44	15:47	15:51	15:53	15:57	15:59	16:01	16:05		**10**
6	137		15:30	15:32	15:34	15:37	15:41	15:43	15:44	15:46	15:47	15:49	15:51	15:54	15:57	16:01	16:03	16:07	16:09	16:11	16:15		**6**
12	139		15:37	15:39	15:41	15:44	15:48	15:50	15:51	15:53	15:54	15:56	15:58	16:01	16:04	16:08	16:10	16:14	16:16	16:18	16:22		**12**
8	141		15:44	15:46	15:48	15:51	15:55	15:57	15:58	16:00	16:01	16:03	16:05	16:08	16:11	16:15	16:17	16:21	16:23	16:25	16:29		**8**
14	143		15:51	15:53	15:55	15:58	16:02	16:04	16:05	16:07	16:08	16:10	16:12	16:15	16:18	16:22	16:24	16:28	16:30	16:32	16:36		**14**
1	145		15:58	16:00	16:02	16:05	16:09	16:11	16:12	16:14	16:15	16:17	16:19	16:22	16:25	16:29	16:31	16:35	16:37	16:39	16:43		**1**
9	147		16:05	16:07	16:09	16:12	16:16	16:18	16:19	16:21	16:22	16:24	16:26	16:29	16:32	16:36	16:38	16:42	16:44	16:46	16:50		**9**
3	149		16:12	16:14	16:16	16:19	16:23	16:25	16:26	16:28	16:29	16:31	16:33	16:36	16:39	16:43	16:45	16:49	16:51	16:53	16:57		**3**
11	151		16:19	16:21	16:23	16:26	16:30	16:32	16:33	16:35	16:36	16:38	16:40	16:43	16:46	16:50	16:52	16:56	16:58	17:00	17:04		**11**
5	153		16:26	16:28	16:30	16:33	16:37	16:39	16:40	16:42	16:43	16:45	16:47	16:50	16:53	16:57	16:59	17:03	17:05	17:07	17:11		**5**
13	155		16:33	16:35	16:37	16:40	16:44	16:46	16:47	16:49	16:50	16:52	16:54	16:57	17:00	17:04	17:06	17:10	17:12	17:14	17:18		**13**
7	157		16:40	16:42	16:44	16:47	16:51	16:53	16:54	16:56	16:57	16:59	17:01	17:04	17:07	17:11	17:13	17:17	17:19	17:21	17:25		**7**
15	159		16:47	16:49	16:51	16:54	16:58	17:00	17:01	17:03	17:04	17:06	17:08	17:11	17:14	17:18	17:20	17:24	17:26	17:28	17:32		**15**
2	161		16:54	16:56	16:58	17:01	17:05	17:07	17:08	17:10	17:11	17:13	17:15	17:18	17:21	17:25	17:27	17:31	17:33	17:35	17:39		**2**
4	163		17:01	17:03	17:05	17:08	17:12	17:14	17:15	17:17	17:18	17:20	17:22	17:25	17:28	17:32	17:34	17:38	17:40	17:42	17:46		**4**
10	165		17:08	17:10	17:12	17:15	17:19	17:21	17:22	17:24	17:25	17:27	17:29	17:32	17:35	17:39	17:41	17:45	17:47	17:49	17:53		**10**
6	167		17:15	17:17	17:19	17:22	17:26	17:28	17:29	17:31	17:32	17:34	17:36	17:39	17:42	17:46	17:48	17:52	17:54	17:56	18:00		**6**
12	169		17:22	17:24	17:26	17:29	17:33	17:35	17:36	17:38	17:39	17:41	17:43	17:46	17:49	17:53	17:55	17:59	18:01	18:03	18:07		**12**
8	171		17:29	17:31	17:33	17:36	17:40	17:42	17:43	17:45	17:46	17:48	17:50	17:53	17:56	18:00	18:02	18:06	18:08	18:10	18:14		**8**
14	173		17:36	17:38	17:40	17:43	17:47	17:49	17:50	17:52	17:53	17:55	17:57	18:00	18:03	18:07	18:09	18:13	18:15	18:17	18:21		**14**
1	175		17:43	17:45	17:47	17:50	17:54	17:56	17:57	17:59	18:00	18:02	18:04	18:07	18:10	18:14	18:16	18:20	18:22	18:24	18:28		**1**
9	177		17:50	17:52	17:54	17:57	18:01	18:03	18:04	18:06	18:07	18:09	18:11	18:14	18:17	18:21	18:23	18:27	18:29	18:31	18:35		**9**

Equipment set #		Yard Pull-out	Bayview MARC	Bayview Campus	Highlandtown	Canton Crossing	Canton	Fell's Point	Harbor East	Inner Harbor	Howard St/ University Center	Poppleton	Harlem Park	EB MARC Station	Rosemont	Allendale EB	Edmondson Village	I-70 Park-and-Ride	S.S. Administration	Security Square	CMS	Yard Pull-in	Equipment set #
3	179		17:57	17:59	18:01	18:04	18:08	18:10	18:11	18:13	18:14	18:16	18:18	18:21	18:24	18:28	18:30	18:34	18:36	18:38	18:42		**3**
11	181		18:04	18:06	18:08	18:11	18:15	18:17	18:18	18:20	18:21	18:23	18:25	18:28	18:31	18:35	18:37	18:41	18:43	18:45	18:49		**11**
5	183		18:11	18:13	18:15	18:18	18:22	18:24	18:25	18:27	18:28	18:30	18:32	18:35	18:38	18:42	18:44	18:48	18:50	18:52	18:56		**5**
13	185		18:18	18:20	18:22	18:25	18:29	18:31	18:32	18:34	18:35	18:37	18:39	18:42	18:45	18:49	18:51	18:55	18:57	18:59	19:03		**13**
7	187		18:25	18:27	18:29	18:32	18:36	18:38	18:39	18:41	18:42	18:44	18:46	18:49	18:52	18:56	18:58	19:02	19:04	19:06	19:10		**7**
15	189		18:32	18:34	18:36	18:39	18:43	18:45	18:46	18:48	18:49	18:51	18:53	18:56	18:59	19:03	19:05	19:09	19:11	19:13	19:17		**15**
2	191		18:40	18:42	18:44	18:47	18:51	18:53	18:54	18:56	18:57	18:59	19:01	19:04	19:07	19:11	19:13	19:17	19:19	19:21	19:25		**2**
4	Y180		18:45	18:47	18:49	18:52	18:56	18:58	18:59	19:01	19:02	19:04	19:06	19:09								19:10	**4**
10	193		18:50	18:52	18:54	18:57	19:01	19:03	19:04	19:06	19:07	19:09	19:11	19:14	19:17	19:21	19:23	19:27	19:29	19:31	19:35		**10**
6	195		19:00	19:02	19:04	19:07	19:11	19:13	19:14	19:16	19:17	19:19	19:21	19:24	19:27	19:31	19:33	19:37	19:39	19:41	19:45		**6**
12	197		19:10	19:12	19:14	19:17	19:21	19:23	19:24	19:26	19:27	19:29	19:31	19:34	19:37	19:41	19:43	19:47	19:49	19:51	19:55		**12**
8	Y188		19:15	19:17	19:19	19:22	19:26	19:28	19:29	19:31	19:32	19:34	19:36	19:39								19:40	**8**
14	199		19:20	19:22	19:24	19:27	19:31	19:33	19:34	19:36	19:37	19:39	19:41	19:44	19:47	19:51	19:53	19:57	19:59	20:01	20:05		**14**
1	201		19:30	19:32	19:34	19:37	19:41	19:43	19:44	19:46	19:47	19:49	19:51	19:54	19:57	20:01	20:03	20:07	20:09	20:11	20:15		**1**
9	203		19:40	19:42	19:44	19:47	19:51	19:53	19:54	19:56	19:57	19:59	20:01	20:04	20:07	20:11	20:13	20:17	20:19	20:21	20:25		**9**
3	205		19:50	19:52	19:54	19:57	20:01	20:03	20:04	20:06	20:07	20:09	20:11	20:14	20:17	20:21	20:23	20:27	20:29	20:31	20:35		**3**
5	207		20:00	20:02	20:04	20:07	20:11	20:13	20:14	20:16	20:17	20:19	20:21	20:24	20:27	20:31	20:33	20:37	20:39	20:41	20:45		**5**
13	209		20:10	20:12	20:14	20:17	20:21	20:23	20:24	20:26	20:27	20:29	20:31	20:34	20:37	20:41	20:43	20:47	20:49	20:51	20:55		**13**
15	211		20:20	20:22	20:24	20:27	20:31	20:33	20:34	20:36	20:37	20:39	20:41	20:44	20:47	20:51	20:53	20:57	20:59	21:01	21:05		**15**
2	213		20:30	20:32	20:34	20:37	20:41	20:43	20:44	20:46	20:47	20:49	20:51	20:54	20:57	21:01	21:03	21:07	21:09	21:11	21:15		**2**
10	215		20:40	20:42	20:44	20:47	20:51	20:53	20:54	20:56	20:57	20:59	21:01	21:04	21:07	21:11	21:13	21:17	21:19	21:21	21:25		**10**
6	217		20:50	20:52	20:54	20:57	21:01	21:03	21:04	21:06	21:07	21:09	21:11	21:14	21:17	21:21	21:23	21:27	21:29	21:31	21:35		**6**
12	219		21:00	21:02	21:04	21:07	21:11	21:13	21:14	21:16	21:17	21:19	21:21	21:24	21:27	21:31	21:33	21:37	21:39	21:41	21:45		**12**
14	221		21:15	21:17	21:19	21:22	21:26	21:28	21:29	21:31	21:32	21:34	21:36	21:39	21:42	21:46	21:48	21:52	21:54	21:56	22:00		**14**
1	Y214		21:20	21:22	21:24	21:27	21:31	21:33	21:34	21:36	21:37	21:39	21:41	21:44								21:45	
9	223		21:30	21:32	21:34	21:37	21:41	21:43	21:44	21:46	21:47	21:49	21:51	21:54	21:57	22:01	22:03	22:07	22:09	22:11	22:15		**9**
3	225		21:45	21:47	21:49	21:52	21:56	21:58	21:59	22:01	22:02	22:04	22:06	22:09	22:12	22:16	22:18	22:22	22:24	22:26	22:30		**3**
5	Y220		21:50	21:52	21:54	21:57	22:01	22:03	22:04	22:06	22:07	22:09	22:11	22:14								22:15	
13	227		22:00	22:02	22:04	22:07	22:11	22:13	22:14	22:16	22:17	22:19	22:21	22:24	22:27	22:31	22:33	22:37	22:39	22:41	22:45		**13**
15	229		22:15	22:17	22:19	22:22	22:26	22:28	22:29	22:31	22:32	22:34	22:36	22:39	22:42	22:46	22:48	22:52	22:54	22:56	23:00		**15**
10	231		22:30	22:32	22:34	22:37	22:41	22:43	22:44	22:46	22:47	22:49	22:51	22:54	22:57	23:01	23:03	23:07	23:09	23:11	23:15		**10**
6	233		22:45	22:47	22:49	22:52	22:56	22:58	22:59	23:01	23:02	23:04	23:06	23:09	23:12	23:16	23:18	23:22	23:24	23:26	23:30		**6**
12	235		23:00	23:02	23:04	23:07	23:11	23:13	23:14	23:16	23:17	23:19	23:21	23:24	23:27	23:31	23:33	23:37	23:39	23:41	23:45		**12**
14	237		23:15	23:17	23:19	23:22	23:26	23:28	23:29	23:31	23:32	23:34	23:36	23:39	23:42	23:46	23:48	23:52	23:54	23:56	0:00		**14**

Equipment set #		Yard Pull-out	Bayview MARC	Bayview Campus	Highlandtown	Canton Crossing	Canton	Fell's Point	Harbor East	Inner Harbor	Howard St/ University Center	Poppleton	Harlem Park	EB MARC Station	Rosemont	Allendale EB	Edmondson Village	I-70 Park-and-Ride	S.S. Administration	Security Square	CMS	Yard Pull-in	Equipment set #
9	239		23:30	23:32	23:34	23:37	23:41	23:43	23:44	23:46	23:47	23:49	23:51	23:54	23:57	0:01	0:03	0:07	0:09	0:11	0:15		**9**
3	241		23:45	23:47	23:49	23:52	23:56	23:58	23:59	0:01	0:02	0:04	0:06	0:09	0:12	0:16	0:18	0:22	0:24	0:26	0:30		**3**
13	243		0:00	0:02	0:04	0:07	0:11	0:13	0:14	0:16	0:17	0:19	0:21	0:24	0:27	0:31	0:33	0:37	0:39	0:41	0:45		**13**
15	245		0:15	0:17	0:19	0:22	0:26	0:28	0:29	0:31	0:32	0:34	0:36	0:39	0:42	0:46	0:48	0:52	0:54	0:56	1:00		**15**
10	247		0:30	0:32	0:34	0:37	0:41	0:43	0:44	0:46	0:47	0:49	0:51	0:54	0:57	1:01	1:03	1:07	1:09	1:11	1:15		**10**
6	249		0:45	0:47	0:49	0:52	0:56	0:58	0:59	1:01	1:02	1:04	1:06	1:09	1:12	1:16	1:18	1:22	1:24	1:26	1:30		**6**
12	251		1:00	1:02	1:04	1:07	1:11	1:13	1:14	1:16	1:17	1:19	1:21	1:24	1:27	1:31	1:33	1:37	1:39	1:41	1:45		**12**
14	Y248		1:15	1:17	1:19	1:22	1:26	1:28	1:29	1:31	1:32	1:34	1:36	1:39								1:40	**14**
9	Y250		1:30	1:32	1:34	1:37	1:41	1:43	1:44	1:46	1:47	1:49	1:51	1:54								1:55	**9**
3	Y252		1:45	1:47	1:49	1:52	1:56	1:58	1:59	2:01	2:02	2:04	2:06	2:09								2:10	**3**
13	Y254		2:00	2:02	2:04	2:07	2:11	2:13	2:14	2:16	2:17	2:19	2:21	2:24								2:25	**13**

Appendix K
2021/2035 Sunday Operating Plan – Eastbound

Equipment set #		Yard Pull-out	CMS	Security Square	S.S. Administration	I-70 Park-and-Ride	Edmondson Village	Allendale EB	Rosemont	EB MARC Station	Harlem Park	Poppleton	Howard St/ University Center	Charles Center	Inner Harbor East	Fell's Point	Canton	Canton Crossing	Highlandtown	Bayview Campus	Bayview MARC	Yard Pull-in	Equipment set #
2	Y001	9:29								9:31	9:34	9:36	9:37	9:38	9:41	9:42	9:44	9:47	9:50	9:53	9:55		**2**
4	Y003	9:39								9:41	9:44	9:46	9:47	9:48	9:51	9:52	9:54	9:57	10:00	10:03	10:05		**4**
6	Y005	9:49								9:51	9:54	9:56	9:57	9:58	10:01	10:02	10:04	10:07	10:10	10:13	10:15		**6**
8	Y007	9:59								10:01	10:04	10:06	10:07	10:08	10:11	10:12	10:14	10:17	10:20	10:23	10:25		**8**
10	Y009	10:09								10:11	10:14	10:16	10:17	10:18	10:21	10:22	10:24	10:27	10:30	10:33	10:35		**10**
1	002		10:00	10:03	10:06	10:08	10:11	10:14	10:17	10:21	10:24	10:26	10:27	10:28	10:31	10:32	10:34	10:37	10:40	10:43	10:45		**1**
3	004		10:10	10:13	10:16	10:18	10:21	10:24	10:27	10:31	10:34	10:36	10:37	10:38	10:41	10:42	10:44	10:47	10:50	10:53	10:55		**3**
5	006		10:20	10:23	10:26	10:28	10:31	10:34	10:37	10:41	10:44	10:46	10:47	10:48	10:51	10:52	10:54	10:57	11:00	11:03	11:05		**5**
7	008		10:30	10:33	10:36	10:38	10:41	10:44	10:47	10:51	10:54	10:56	10:57	10:58	11:01	11:02	11:04	11:07	11:10	11:13	11:15		**7**
9	010		10:40	10:43	10:46	10:48	10:51	10:54	10:57	11:01	11:04	11:06	11:07	11:08	11:11	11:12	11:14	11:17	11:20	11:23	11:25		**9**
11	012		10:50	10:53	10:56	10:58	11:01	11:04	11:07	11:11	11:14	11:16	11:17	11:18	11:21	11:22	11:24	11:27	11:30	11:33	11:35		**11**
2	014		11:00	11:03	11:06	11:08	11:11	11:14	11:17	11:21	11:24	11:26	11:27	11:28	11:31	11:32	11:34	11:37	11:40	11:43	11:45		**2**
4	016		11:10	11:13	11:16	11:18	11:21	11:24	11:27	11:31	11:34	11:36	11:37	11:38	11:41	11:42	11:44	11:47	11:50	11:53	11:55		**4**
6	018		11:20	11:23	11:26	11:28	11:31	11:34	11:37	11:41	11:44	11:46	11:47	11:48	11:51	11:52	11:54	11:57	12:00	12:03	12:05		**6**
8	020		11:30	11:33	11:36	11:38	11:41	11:44	11:47	11:51	11:54	11:56	11:57	11:58	12:01	12:02	12:04	12:07	12:10	12:13	12:15		**8**
10	022		11:40	11:43	11:46	11:48	11:51	11:54	11:57	12:01	12:04	12:06	12:07	12:08	12:11	12:12	12:14	12:17	12:20	12:23	12:25		**10**
1	024		11:50	11:53	11:56	11:58	12:01	12:04	12:07	12:11	12:14	12:16	12:17	12:18	12:21	12:22	12:24	12:27	12:30	12:33	12:35		**1**
3	026		12:00	12:03	12:06	12:08	12:11	12:14	12:17	12:21	12:24	12:26	12:27	12:28	12:31	12:32	12:34	12:37	12:40	12:43	12:45		**3**
5	028		12:10	12:13	12:16	12:18	12:21	12:24	12:27	12:31	12:34	12:36	12:37	12:38	12:41	12:42	12:44	12:47	12:50	12:53	12:55		**5**
7	030		12:20	12:23	12:26	12:28	12:31	12:34	12:37	12:41	12:44	12:46	12:47	12:48	12:51	12:52	12:54	12:57	13:00	13:03	13:05		**7**
9	032		12:30	12:33	12:36	12:38	12:41	12:44	12:47	12:51	12:54	12:56	12:57	12:58	13:01	13:02	13:04	13:07	13:10	13:13	13:15		**9**
11	034		12:40	12:43	12:46	12:48	12:51	12:54	12:57	13:01	13:04	13:06	13:07	13:08	13:11	13:12	13:14	13:17	13:20	13:23	13:25		**11**
2	036		12:50	12:53	12:56	12:58	13:01	13:04	13:07	13:11	13:14	13:16	13:17	13:18	13:21	13:22	13:24	13:27	13:30	13:33	13:35		**2**
4	038		13:00	13:03	13:06	13:08	13:11	13:14	13:17	13:21	13:24	13:26	13:27	13:28	13:31	13:32	13:34	13:37	13:40	13:43	13:45		**4**
6	040		13:10	13:13	13:16	13:18	13:21	13:24	13:27	13:31	13:34	13:36	13:37	13:38	13:41	13:42	13:44	13:47	13:50	13:53	13:55		**6**
8	042		13:20	13:23	13:26	13:28	13:31	13:34	13:37	13:41	13:44	13:46	13:47	13:48	13:51	13:52	13:54	13:57	14:00	14:03	14:05		**8**
10	044		13:30	13:33	13:36	13:38	13:41	13:44	13:47	13:51	13:54	13:56	13:57	13:58	14:01	14:02	14:04	14:07	14:10	14:13	14:15		**10**
1	046		13:40	13:43	13:46	13:48	13:51	13:54	13:57	14:01	14:04	14:06	14:07	14:08	14:11	14:12	14:14	14:17	14:20	14:23	14:25		**1**
3	048		13:50	13:53	13:56	13:58	14:01	14:04	14:07	14:11	14:14	14:16	14:17	14:18	14:21	14:22	14:24	14:27	14:30	14:33	14:35		**3**
5	050		14:00	14:03	14:06	14:08	14:11	14:14	14:17	14:21	14:24	14:26	14:27	14:28	14:31	14:32	14:34	14:37	14:40	14:43	14:45		**5**
7	052		14:10	14:13	14:16	14:18	14:21	14:24	14:27	14:31	14:34	14:36	14:37	14:38	14:41	14:42	14:44	14:47	14:50	14:53	14:55		**7**
9	054		14:20	14:23	14:26	14:28	14:31	14:34	14:37	14:41	14:44	14:46	14:47	14:48	14:51	14:52	14:54	14:57	15:00	15:03	15:05		**9**
11	056		14:30	14:33	14:36	14:38	14:41	14:44	14:47	14:51	14:54	14:56	14:57	14:58	15:01	15:02	15:04	15:07	15:10	15:13	15:15		**11**

Equipment set #		Yard Pull-out	CMS	Security Square	S.S. Administration	I-70 Park-and-Ride	Edmondson Village	Allendale EB	Rosemont	EB MARC Station	Harlem Park	Poppleton	Howard St/ University Center	Charles Center	Inner Harbor East	Fell's Point	Canton	Canton Crossing	Highlandtown	Bayview Campus	Bayview MARC	Yard Pull-in	Equipment set #
2	058		14:40	14:43	14:46	14:48	14:51	14:54	14:57	15:01	15:04	15:06	15:07	15:08	15:11	15:12	15:14	15:17	15:20	15:23	15:25		**2**
4	060		14:50	14:53	14:56	14:58	15:01	15:04	15:07	15:11	15:14	15:16	15:17	15:18	15:21	15:22	15:24	15:27	15:30	15:33	15:35		**4**
6	062		15:00	15:03	15:06	15:08	15:11	15:14	15:17	15:21	15:24	15:26	15:27	15:28	15:31	15:32	15:34	15:37	15:40	15:43	15:45		**6**
8	064		15:10	15:13	15:16	15:18	15:21	15:24	15:27	15:31	15:34	15:36	15:37	15:38	15:41	15:42	15:44	15:47	15:50	15:53	15:55		**8**
10	066		15:20	15:23	15:26	15:28	15:31	15:34	15:37	15:41	15:44	15:46	15:47	15:48	15:51	15:52	15:54	15:57	16:00	16:03	16:05		**10**
1	068		15:30	15:33	15:36	15:38	15:41	15:44	15:47	15:51	15:54	15:56	15:57	15:58	16:01	16:02	16:04	16:07	16:10	16:13	16:15		**1**
3	070		15:40	15:43	15:46	15:48	15:51	15:54	15:57	16:01	16:04	16:06	16:07	16:08	16:11	16:12	16:14	16:17	16:20	16:23	16:25		**3**
5	072		15:50	15:53	15:56	15:58	16:01	16:04	16:07	16:11	16:14	16:16	16:17	16:18	16:21	16:22	16:24	16:27	16:30	16:33	16:35		**5**
7	074		16:00	16:03	16:06	16:08	16:11	16:14	16:17	16:21	16:24	16:26	16:27	16:28	16:31	16:32	16:34	16:37	16:40	16:43	16:45		**7**
9	076		16:10	16:13	16:16	16:18	16:21	16:24	16:27	16:31	16:34	16:36	16:37	16:38	16:41	16:42	16:44	16:47	16:50	16:53	16:55		**9**
11	078		16:20	16:23	16:26	16:28	16:31	16:34	16:37	16:41	16:44	16:46	16:47	16:48	16:51	16:52	16:54	16:57	17:00	17:03	17:05		**11**
2	080		16:30	16:33	16:36	16:38	16:41	16:44	16:47	16:51	16:54	16:56	16:57	16:58	17:01	17:02	17:04	17:07	17:10	17:13	17:15		**2**
4	082		16:40	16:43	16:46	16:48	16:51	16:54	16:57	17:01	17:04	17:06	17:07	17:08	17:11	17:12	17:14	17:17	17:20	17:23	17:25		**4**
6	084		16:50	16:53	16:56	16:58	17:01	17:04	17:07	17:11	17:14	17:16	17:17	17:18	17:21	17:22	17:24	17:27	17:30	17:33	17:35		**6**
8	086		17:00	17:03	17:06	17:08	17:11	17:14	17:17	17:21	17:24	17:26	17:27	17:28	17:31	17:32	17:34	17:37	17:40	17:43	17:45		**8**
10	088		17:10	17:13	17:16	17:18	17:21	17:24	17:27	17:31	17:34	17:36	17:37	17:38	17:41	17:42	17:44	17:47	17:50	17:53	17:55		**10**
1	090		17:20	17:23	17:26	17:28	17:31	17:34	17:37	17:41	17:44	17:46	17:47	17:48	17:51	17:52	17:54	17:57	18:00	18:03	18:05		**1**
3	092		17:30	17:33	17:36	17:38	17:41	17:44	17:47	17:51	17:54	17:56	17:57	17:58	18:01	18:02	18:04	18:07	18:10	18:13	18:15		**3**
5	094		17:40	17:43	17:46	17:48	17:51	17:54	17:57	18:01	18:04	18:06	18:07	18:08	18:11	18:12	18:14	18:17	18:20	18:23	18:25		**5**
7	096		17:50	17:53	17:56	17:58	18:01	18:04	18:07	18:11	18:14	18:16	18:17	18:18	18:21	18:22	18:24	18:27	18:30	18:33	18:35		**7**
9	098		18:00	18:03	18:06	18:08	18:11	18:14	18:17	18:21	18:24	18:26	18:27	18:28	18:31	18:32	18:34	18:37	18:40	18:43	18:45		**9**
11	100		18:10	18:13	18:16	18:18	18:21	18:24	18:27	18:31	18:34	18:36	18:37	18:38	18:41	18:42	18:44	18:47	18:50	18:53	18:55		**11**
2	102		18:20	18:23	18:26	18:28	18:31	18:34	18:37	18:41	18:44	18:46	18:47	18:48	18:51	18:52	18:54	18:57	19:00	19:03	19:05		**2**
4	104		18:30	18:33	18:36	18:38	18:41	18:44	18:47	18:51	18:54	18:56	18:57	18:58	19:01	19:02	19:04	19:07	19:10	19:13	19:15		**4**
6	106		18:40	18:43	18:46	18:48	18:51	18:54	18:57	19:01	19:04	19:06	19:07	19:08	19:11	19:12	19:14	19:17	19:20	19:23	19:25		**6**
8	108		18:50	18:53	18:56	18:58	19:01	19:04	19:07	19:11	19:14	19:16	19:17	19:18	19:21	19:22	19:24	19:27	19:30	19:33	19:35		**8**
10	110		19:00	19:03	19:06	19:08	19:11	19:14	19:17	19:21	19:24	19:26	19:27	19:28	19:31	19:32	19:34	19:37	19:40	19:43	19:45		**10**
1	112		19:10	19:13	19:16	19:18	19:21	19:24	19:27	19:31	19:34	19:36	19:37	19:38	19:41	19:42	19:44	19:47	19:50	19:53	19:55		**1**
3	114		19:20	19:23	19:26	19:28	19:31	19:34	19:37	19:41	19:44	19:46	19:47	19:48	19:51	19:52	19:54	19:57	20:00	20:03	20:05		**3**
5	116		19:30	19:33	19:36	19:38	19:41	19:44	19:47	19:51	19:54	19:56	19:57	19:58	20:01	20:02	20:04	20:07	20:10	20:13	20:15		**5**
7	118		19:40	19:43	19:46	19:48	19:51	19:54	19:57	20:01	20:04	20:06	20:07	20:08	20:11	20:12	20:14	20:17	20:20	20:23	20:25		**7**
9	120		19:50	19:53	19:56	19:58	20:01	20:04	20:07	20:11	20:14	20:16	20:17	20:18	20:21	20:22	20:24	20:27	20:30	20:33	20:35		**9**
11	122		20:00	20:03	20:06	20:08	20:11	20:14	20:17	20:21	20:24	20:26	20:27	20:28	20:31	20:32	20:34	20:37	20:40	20:43	20:45		**11**
2	124		20:10	20:13	20:16	20:18	20:21	20:24	20:27	20:31	20:34	20:36	20:37	20:38	20:41	20:42	20:44	20:47	20:50	20:53	20:55		**2**

Equipment set #		**Yard Pull-out**	**CMS**	**Security Square**	**S.S. Administration**	**I-70 Park-and-Ride**	**Edmondson Village**	**Allendale EB**	**Rosemont**	**EB MARC Station**	**Harlem Park**	**Poppleton**	**Howard St/ University Center**	**Charles Center**	**Inner Harbor East**	**Fell's Point**	**Canton**	**Canton Crossing**	**Highlandtown**	**Bayview Campus**	**Bayview MARC**	**Yard Pull-in**	**Equipment set #**
4	126		20:20	20:23	20:26	20:28	20:31	20:34	20:37	20:41	20:44	20:46	20:47	20:48	20:51	20:52	20:54	20:57	21:00	21:03	21:05		**4**
6	128		20:30	20:33	20:36	20:38	20:41	20:44	20:47	20:51	20:54	20:56	20:57	20:58	21:01	21:02	21:04	21:07	21:10	21:13	21:15		**6**
8	130		20:40	20:43	20:46	20:48	20:51	20:54	20:57	21:01	21:04	21:06	21:07	21:08	21:11	21:12	21:14	21:17	21:20	21:23	21:25		**8**
10	132		20:50	20:53	20:56	20:58	21:01	21:04	21:07	21:11	21:14	21:16	21:17	21:18	21:21	21:22	21:24	21:27	21:30	21:33	21:35		**10**
1	134		21:00	21:03	21:06	21:08	21:11	21:14	21:17	21:21	21:24	21:26	21:27	21:28	21:31	21:32	21:34	21:37	21:40	21:43	21:45		**1**
3	136		21:10	21:13	21:16	21:18	21:21	21:24	21:27	21:31	21:34	21:36	21:37	21:38	21:41	21:42	21:44	21:47	21:50	21:53	21:55		**3**
5	138		21:20	21:23	21:26	21:28	21:31	21:34	21:37	21:41	21:44	21:46	21:47	21:48	21:51	21:52	21:54	21:57	22:00	22:03	22:05		**5**
7	140		21:30	21:33	21:36	21:38	21:41	21:44	21:47	21:51	21:54	21:56	21:57	21:58	22:01	22:02	22:04	22:07	22:10	22:13	22:15		**7**
9	142		21:40	21:43	21:46	21:48	21:51	21:54	21:57	22:01	22:04	22:06	22:07	22:08	22:11	22:12	22:14	22:17	22:20	22:23	22:25		**9**
11	144		21:50	21:53	21:56	21:58	22:01	22:04	22:07	22:11	22:14	22:16	22:17	22:18	22:21	22:22	22:24	22:27	22:30	22:33	22:35		**11**
2	146		22:00	22:03	22:06	22:08	22:11	22:14	22:17	22:21	22:24	22:26	22:27	22:28	22:31	22:32	22:34	22:37	22:40	22:43	22:45		**2**
4	Y135		22:10	22:13	22:16	22:18	22:21	22:24	22:27													22:28	**4**
6	Y137		22:20	22:23	22:26	22:28	22:31	22:34	22:37													22:38	**6**
8	Y139		22:30	22:33	22:36	22:38	22:41	22:44	22:47													22:48	**8**
10	Y141		22:40	22:43	22:46	22:48	22:51	22:54	22:57													22:58	**10**
1	Y143		22:50	22:53	22:56	22:58	23:01	23:04	23:07													23:08	**1**

Appendix L: 2021/2035 Sunday Operating Plan – Westbound

Equipment set #		Yard Pull-out	Bayview MARC	Bayview Campus	Highlandtown	Canton Crossing	Canton	Fell's Point	Harbor East	Inner Harbor	Howard St/ University Center	Poppleton	Harlem Park	EB MARC Station	Rosemont	Allendale EB	Edmondson Village	I-70 Park-and-Ride	S.S. Administration	Security Square	CMS	Yard Pull-in	Equipment set #
1	Y002	9:31													9:32	9:36	9:38	9:42	9:44	9:46	9:50		**1**
3	Y004	9:41													9:42	9:46	9:48	9:52	9:54	9:56	10:00		**3**
5	Y006	9:51													9:52	9:56	9:58	10:02	10:04	10:06	10:10		**5**
7	Y008	10:01													10:02	10:06	10:08	10:12	10:14	10:16	10:20		**7**
9	Y010	10:11													10:12	10:16	10:18	10:22	10:24	10:26	10:30		**9**
11	Y012	10:21													10:22	10:26	10:28	10:32	10:34	10:36	10:40		**11**
2	001		10:05	10:07	10:09	10:12	10:16	10:18	10:19	10:21	10:22	10:24	10:26	10:29	10:32	10:36	10:38	10:42	10:44	10:46	10:50		**2**
4	003		10:15	10:17	10:19	10:22	10:26	10:28	10:29	10:31	10:32	10:34	10:36	10:39	10:42	10:46	10:48	10:52	10:54	10:56	11:00		**4**
6	005		10:25	10:27	10:29	10:32	10:36	10:38	10:39	10:41	10:42	10:44	10:46	10:49	10:52	10:56	10:58	11:02	11:04	11:06	11:10		**6**
8	007		10:35	10:37	10:39	10:42	10:46	10:48	10:49	10:51	10:52	10:54	10:56	10:59	11:02	11:06	11:08	11:12	11:14	11:16	11:20		**8**
10	009		10:45	10:47	10:49	10:52	10:56	10:58	10:59	11:01	11:02	11:04	11:06	11:09	11:12	11:16	11:18	11:22	11:24	11:26	11:30		**10**
1	011		10:55	10:57	10:59	11:02	11:06	11:08	11:09	11:11	11:12	11:14	11:16	11:19	11:22	11:26	11:28	11:32	11:34	11:36	11:40		**1**
3	013		11:05	11:07	11:09	11:12	11:16	11:18	11:19	11:21	11:22	11:24	11:26	11:29	11:32	11:36	11:38	11:42	11:44	11:46	11:50		**3**
5	015		11:15	11:17	11:19	11:22	11:26	11:28	11:29	11:31	11:32	11:34	11:36	11:39	11:42	11:46	11:48	11:52	11:54	11:56	12:00		**5**
7	017		11:25	11:27	11:29	11:32	11:36	11:38	11:39	11:41	11:42	11:44	11:46	11:49	11:52	11:56	11:58	12:02	12:04	12:06	12:10		**7**
9	019		11:35	11:37	11:39	11:42	11:46	11:48	11:49	11:51	11:52	11:54	11:56	11:59	12:02	12:06	12:08	12:12	12:14	12:16	12:20		**9**
11	021		11:45	11:47	11:49	11:52	11:56	11:58	11:59	12:01	12:02	12:04	12:06	12:09	12:12	12:16	12:18	12:22	12:24	12:26	12:30		**11**
2	023		11:55	11:57	11:59	12:02	12:06	12:08	12:09	12:11	12:12	12:14	12:16	12:19	12:22	12:26	12:28	12:32	12:34	12:36	12:40		**2**
4	025		12:05	12:07	12:09	12:12	12:16	12:18	12:19	12:21	12:22	12:24	12:26	12:29	12:32	12:36	12:38	12:42	12:44	12:46	12:50		**4**
6	027		12:15	12:17	12:19	12:22	12:26	12:28	12:29	12:31	12:32	12:34	12:36	12:39	12:42	12:46	12:48	12:52	12:54	12:56	13:00		**6**
8	029		12:25	12:27	12:29	12:32	12:36	12:38	12:39	12:41	12:42	12:44	12:46	12:49	12:52	12:56	12:58	13:02	13:04	13:06	13:10		**8**
10	031		12:35	12:37	12:39	12:42	12:46	12:48	12:49	12:51	12:52	12:54	12:56	12:59	13:02	13:06	13:08	13:12	13:14	13:16	13:20		**10**
1	033		12:45	12:47	12:49	12:52	12:56	12:58	12:59	13:01	13:02	13:04	13:06	13:09	13:12	13:16	13:18	13:22	13:24	13:26	13:30		**1**
3	035		12:55	12:57	12:59	13:02	13:06	13:08	13:09	13:11	13:12	13:14	13:16	13:19	13:22	13:26	13:28	13:32	13:34	13:36	13:40		**3**
5	037		13:05	13:07	13:09	13:12	13:16	13:18	13:19	13:21	13:22	13:24	13:26	13:29	13:32	13:36	13:38	13:42	13:44	13:46	13:50		**5**
7	039		13:15	13:17	13:19	13:22	13:26	13:28	13:29	13:31	13:32	13:34	13:36	13:39	13:42	13:46	13:48	13:52	13:54	13:56	14:00		**7**
9	041		13:25	13:27	13:29	13:32	13:36	13:38	13:39	13:41	13:42	13:44	13:46	13:49	13:52	13:56	13:58	14:02	14:04	14:06	14:10		**9**
11	043		13:35	13:37	13:39	13:42	13:46	13:48	13:49	13:51	13:52	13:54	13:56	13:59	14:02	14:06	14:08	14:12	14:14	14:16	14:20		**11**
2	045		13:45	13:47	13:49	13:52	13:56	13:58	13:59	14:01	14:02	14:04	14:06	14:09	14:12	14:16	14:18	14:22	14:24	14:26	14:30		**2**
4	047		13:55	13:57	13:59	14:02	14:06	14:08	14:09	14:11	14:12	14:14	14:16	14:19	14:22	14:26	14:28	14:32	14:34	14:36	14:40		**4**
6	049		14:05	14:07	14:09	14:12	14:16	14:18	14:19	14:21	14:22	14:24	14:26	14:29	14:32	14:36	14:38	14:42	14:44	14:46	14:50		**6**
8	051		14:15	14:17	14:19	14:22	14:26	14:28	14:29	14:31	14:32	14:34	14:36	14:39	14:42	14:46	14:48	14:52	14:54	14:56	15:00		**8**

Equipment set #		Yard Pull-out	Bayview MARC	Bayview Campus	Highlandtown	Canton Crossing	Canton	Fell's Point	Harbor East	Inner Harbor	Howard St/ University Center	Poppleton	Harlem Park	EB MARC Station	Rosemont	Allendale EB	Edmondson Village	I-70 Park-and-Ride	S.S. Administration	Security Square	CMS	Yard Pull-in	Equipment set #
10	053		14:25	14:27	14:29	14:32	14:36	14:38	14:39	14:41	14:42	14:44	14:46	14:49	14:52	14:56	14:58	15:02	15:04	15:06	15:10		**10**
1	055		14:35	14:37	14:39	14:42	14:46	14:48	14:49	14:51	14:52	14:54	14:56	14:59	15:02	15:06	15:08	15:12	15:14	15:16	15:20		**1**
3	057		14:45	14:47	14:49	14:52	14:56	14:58	14:59	15:01	15:02	15:04	15:06	15:09	15:12	15:16	15:18	15:22	15:24	15:26	15:30		**3**
5	059		14:55	14:57	14:59	15:02	15:06	15:08	15:09	15:11	15:12	15:14	15:16	15:19	15:22	15:26	15:28	15:32	15:34	15:36	15:40		**5**
7	061		15:05	15:07	15:09	15:12	15:16	15:18	15:19	15:21	15:22	15:24	15:26	15:29	15:32	15:36	15:38	15:42	15:44	15:46	15:50		**7**
9	063		15:15	15:17	15:19	15:22	15:26	15:28	15:29	15:31	15:32	15:34	15:36	15:39	15:42	15:46	15:48	15:52	15:54	15:56	16:00		**9**
11	065		15:25	15:27	15:29	15:32	15:36	15:38	15:39	15:41	15:42	15:44	15:46	15:49	15:52	15:56	15:58	16:02	16:04	16:06	16:10		**11**
2	067		15:35	15:37	15:39	15:42	15:46	15:48	15:49	15:51	15:52	15:54	15:56	15:59	16:02	16:06	16:08	16:12	16:14	16:16	16:20		**2**
4	069		15:45	15:47	15:49	15:52	15:56	15:58	15:59	16:01	16:02	16:04	16:06	16:09	16:12	16:16	16:18	16:22	16:24	16:26	16:30		**4**
6	071		15:55	15:57	15:59	16:02	16:06	16:08	16:09	16:11	16:12	16:14	16:16	16:19	16:22	16:26	16:28	16:32	16:34	16:36	16:40		**6**
8	073		16:05	16:07	16:09	16:12	16:16	16:18	16:19	16:21	16:22	16:24	16:26	16:29	16:32	16:36	16:38	16:42	16:44	16:46	16:50		**8**
10	075		16:15	16:17	16:19	16:22	16:26	16:28	16:29	16:31	16:32	16:34	16:36	16:39	16:42	16:46	16:48	16:52	16:54	16:56	17:00		**10**
1	077		16:25	16:27	16:29	16:32	16:36	16:38	16:39	16:41	16:42	16:44	16:46	16:49	16:52	16:56	16:58	17:02	17:04	17:06	17:10		**1**
3	079		16:35	16:37	16:39	16:42	16:46	16:48	16:49	16:51	16:52	16:54	16:56	16:59	17:02	17:06	17:08	17:12	17:14	17:16	17:20		**3**
5	081		16:45	16:47	16:49	16:52	16:56	16:58	16:59	17:01	17:02	17:04	17:06	17:09	17:12	17:16	17:18	17:22	17:24	17:26	17:30		**5**
7	083		16:55	16:57	16:59	17:02	17:06	17:08	17:09	17:11	17:12	17:14	17:16	17:19	17:22	17:26	17:28	17:32	17:34	17:36	17:40		**7**
9	085		17:05	17:07	17:09	17:12	17:16	17:18	17:19	17:21	17:22	17:24	17:26	17:29	17:32	17:36	17:38	17:42	17:44	17:46	17:50		**9**
11	087		17:15	17:17	17:19	17:22	17:26	17:28	17:29	17:31	17:32	17:34	17:36	17:39	17:42	17:46	17:48	17:52	17:54	17:56	18:00		**11**
2	089		17:25	17:27	17:29	17:32	17:36	17:38	17:39	17:41	17:42	17:44	17:46	17:49	17:52	17:56	17:58	18:02	18:04	18:06	18:10		**2**
4	091		17:35	17:37	17:39	17:42	17:46	17:48	17:49	17:51	17:52	17:54	17:56	17:59	18:02	18:06	18:08	18:12	18:14	18:16	18:20		**4**
6	093		17:45	17:47	17:49	17:52	17:56	17:58	17:59	18:01	18:02	18:04	18:06	18:09	18:12	18:16	18:18	18:22	18:24	18:26	18:30		**6**
8	095		17:55	17:57	17:59	18:02	18:06	18:08	18:09	18:11	18:12	18:14	18:16	18:19	18:22	18:26	18:28	18:32	18:34	18:36	18:40		**8**
10	097		18:05	18:07	18:09	18:12	18:16	18:18	18:19	18:21	18:22	18:24	18:26	18:29	18:32	18:36	18:38	18:42	18:44	18:46	18:50		**10**
1	099		18:15	18:17	18:19	18:22	18:26	18:28	18:29	18:31	18:32	18:34	18:36	18:39	18:42	18:46	18:48	18:52	18:54	18:56	19:00		**1**
3	101		18:25	18:27	18:29	18:32	18:36	18:38	18:39	18:41	18:42	18:44	18:46	18:49	18:52	18:56	18:58	19:02	19:04	19:06	19:10		**3**
5	103		18:35	18:37	18:39	18:42	18:46	18:48	18:49	18:51	18:52	18:54	18:56	18:59	19:02	19:06	19:08	19:12	19:14	19:16	19:20		**5**
7	105		18:45	18:47	18:49	18:52	18:56	18:58	18:59	19:01	19:02	19:04	19:06	19:09	19:12	19:16	19:18	19:22	19:24	19:26	19:30		**7**
9	107		18:55	18:57	18:59	19:02	19:06	19:08	19:09	19:11	19:12	19:14	19:16	19:19	19:22	19:26	19:28	19:32	19:34	19:36	19:40		**9**
11	109		19:05	19:07	19:09	19:12	19:16	19:18	19:19	19:21	19:22	19:24	19:26	19:29	19:32	19:36	19:38	19:42	19:44	19:46	19:50		**11**
2	111		19:15	19:17	19:19	19:22	19:26	19:28	19:29	19:31	19:32	19:34	19:36	19:39	19:42	19:46	19:48	19:52	19:54	19:56	20:00		**2**
4	113		19:25	19:27	19:29	19:32	19:36	19:38	19:39	19:41	19:42	19:44	19:46	19:49	19:52	19:56	19:58	20:02	20:04	20:06	20:10		**4**
6	115		19:35	19:37	19:39	19:42	19:46	19:48	19:49	19:51	19:52	19:54	19:56	19:59	20:02	20:06	20:08	20:12	20:14	20:16	20:20		**6**
8	117		19:45	19:47	19:49	19:52	19:56	19:58	19:59	20:01	20:02	20:04	20:06	20:09	20:12	20:16	20:18	20:22	20:24	20:26	20:30		**8**
10	119		19:55	19:57	19:59	20:02	20:06	20:08	20:09	20:11	20:12	20:14	20:16	20:19	20:22	20:26	20:28	20:32	20:34	20:36	20:40		**10**

Equipment set #		**Yard Pull-out**	**Bayview MARC**	**Bayview Campus**	**Highlandtown**	**Canton Crossing**	**Canton**	**Fell's Point**	**Harbor East**	**Inner Harbor**	**Howard St/ University Center**	**Poppleton**	**Harlem Park**	**EB MARC Station**	**Rosemont**	**Allendale EB**	**Edmondson Village**	**I-70 Park-and-Ride**	**S.S. Administration**	**Security Square**	**CMS**	**Yard Pull-in**	**Equipment set #**
1	121		20:05	20:07	20:09	20:12	20:16	20:18	20:19	20:21	20:22	20:24	20:26	20:29	20:32	20:36	20:38	20:42	20:44	20:46	20:50		**1**
3	123		20:15	20:17	20:19	20:22	20:26	20:28	20:29	20:31	20:32	20:34	20:36	20:39	20:42	20:46	20:48	20:52	20:54	20:56	21:00		**3**
5	125		20:25	20:27	20:29	20:32	20:36	20:38	20:39	20:41	20:42	20:44	20:46	20:49	20:52	20:56	20:58	21:02	21:04	21:06	21:10		**5**
7	127		20:35	20:37	20:39	20:42	20:46	20:48	20:49	20:51	20:52	20:54	20:56	20:59	21:02	21:06	21:08	21:12	21:14	21:16	21:20		**7**
9	129		20:45	20:47	20:49	20:52	20:56	20:58	20:59	21:01	21:02	21:04	21:06	21:09	21:12	21:16	21:18	21:22	21:24	21:26	21:30		**9**
11	131		20:55	20:57	20:59	21:02	21:06	21:08	21:09	21:11	21:12	21:14	21:16	21:19	21:22	21:26	21:28	21:32	21:34	21:36	21:40		**11**
2	133		21:05	21:07	21:09	21:12	21:16	21:18	21:19	21:21	21:22	21:24	21:26	21:29	21:32	21:36	21:38	21:42	21:44	21:46	21:50		**2**
4	135		21:15	21:17	21:19	21:22	21:26	21:28	21:29	21:31	21:32	21:34	21:36	21:39	21:42	21:46	21:48	21:52	21:54	21:56	22:00		**4**
6	137		21:25	21:27	21:29	21:32	21:36	21:38	21:39	21:41	21:42	21:44	21:46	21:49	21:52	21:56	21:58	22:02	22:04	22:06	22:10		**6**
8	139		21:35	21:37	21:39	21:42	21:46	21:48	21:49	21:51	21:52	21:54	21:56	21:59	22:02	22:06	22:08	22:12	22:14	22:16	22:20		**8**
10	141		21:45	21:47	21:49	21:52	21:56	21:58	21:59	22:01	22:02	22:04	22:06	22:09	22:12	22:16	22:18	22:22	22:24	22:26	22:30		**10**
1	143		21:55	21:57	21:59	22:02	22:06	22:08	22:09	22:11	22:12	22:14	22:16	22:19	22:22	22:26	22:28	22:32	22:34	22:36	22:40		**1**
3	Y136		22:05	22:07	22:09	22:12	22:16	22:18	22:19	22:21	22:22	22:24	22:26	22:29								22:30	**3**
5	Y138		22:15	22:17	22:19	22:22	22:26	22:28	22:29	22:31	22:32	22:34	22:36	22:39								22:40	**5**
7	Y140		22:25	22:27	22:29	22:32	22:36	22:38	22:39	22:41	22:42	22:44	22:46	22:49								22:50	**7**
9	Y142		22:35	22:37	22:39	22:42	22:46	22:48	22:49	22:51	22:52	22:54	22:56	22:59								23:00	**9**
11	Y144		22:45	22:47	22:49	22:52	22:56	22:58	22:59	23:01	23:02	23:04	23:06	23:09								23:10	**11**
2	Y146		22:55	22:57	22:59	23:02	23:06	23:08	23:09	23:11	23:12	23:14	23:16	23:19								23:20	**2**

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION

MARYLAND TRANSIT ADMINISTRATION

Baltimore, Maryland

Baltimore Red Line

Red Line General Engineering Consultant

Purpose and Need Technical Report
December 2012

Document No.
1723

Table of Contents

1. Introduction

The purpose and need statement establishes why the sponsoring agency is proposing to construct a significant Federally-funded project. A well-defined, established and justified purpose and need assists in the determination of which alternatives are reasonable, prudent and practicable. The purpose and need helps to justify why impacts are acceptable based on the project's importance and need. The purpose and need drives the process for alternatives consideration, in-depth analysis, and ultimately, the selection of a Preferred Alternative. The transportation planning process can serve as the primary source of information for establishing purpose and need, as well as evaluating alternatives.

The need for an east-west transit route through the Baltimore Region was identified in the 2002 *Baltimore Regional Rail System Plan* where the Red Line was designated as a priority project. The purpose and need for the Red Line project was first defined and presented to the public during the Scoping process in 2003.

The Maryland Transit Administration (MTA), in coordination with the Federal Transit Administration (FTA), is considering the implementation of the Red Line light rail transit line from western Baltimore County through the central business district (CBD) to eastern Baltimore City. The Red Line project is intended to improve system connectivity, transportation choices, and mobility in the project study corridor, as well as support economic development efforts and help improve regional air quality.

The purpose of this technical report is to provide supporting documentation for the purpose and need presented in Chapter 1 of the Final Environmental Impact Statement (FEIS) for the Red Line project. Section 2 of the report describes the project purpose. Section 3 describes the project needs. Section 4 includes the background and supporting documentation for the purpose and need. Section 4 also serves as an update to the detailed information included in Chapter 1 (Purpose and Need) of the 2009 Alternatives Analysis/Draft Environmental Impact Statement (AA/DEIS).

The traffic data and information contained in this chapter can be found in the *Traffic and Parking Technical Report*.

2. Purpose of the Project

The Red Line project is just one step in the ongoing development of an interconnected regional transit system that would improve the quality of transit service in the Baltimore Region. The purpose of the Red Line project is to provide the following improvements in the project study corridor, which extends from the Centers for Medicare & Medicaid Services (CMS) in Baltimore County to the Johns Hopkins Bayview Medical Center campus in Baltimore City:

- Improve transit efficiency by reducing travel times for transit trips in the corridor;
- Increase transit accessibility in the corridor by providing improved transit access to major employment and activity centers;
- Provide transportation choices for east-west commuters in the corridor by making transit a more attractive option;
- Enhance connections among existing transit routes in the corridor;
- Support community revitalization and economic development opportunities in the corridor; and
- Help the region improve air quality by increasing transit use and promoting environmental stewardship.

3. Project Needs

The needs that exist in the project study corridor are:

- Roadway congestion contributes to slow travel times for automobiles and buses in the corridor;
- Lack of convenient transit access to existing and future activity centers in the corridor, including downtown Baltimore, Fell's Point, and Canton, as well as employment areas in Baltimore County to the west of Baltimore;
- Lack of viable transit options for east-west commuters in the corridor;
- Lack of connections from existing transit routes (including Central Light Rail, Metro, MARC, and bus network) to the I-70 travel market on the west side of the corridor, and to the I-95 and East Baltimore travel markets on the east;
- Need for economic development and community revitalization in communities along the corridor, both in Baltimore County and in Baltimore City; and,
- Need to support the regional goal of improving air quality by providing alternatives to automobile usage.

These needs are described in detail in **Sections 3.1** through **3.6** below.

3.1 Roadway Congestion and Slow Travel Times

The project study corridor currently faces traffic congestion, affecting both automobiles and buses. The main link in the project study corridor, US 40, is a heavily traveled arterial with high density residential and commercial activities throughout much of its length into downtown. There are many aspects of US 40 that contribute to the congestion and slow travel speeds, but most significant are the numerous and closely spaced traffic signals along the length of the project study corridor.

During peak travel periods, traffic speeds on US 40 range between 10-42 miles per hour (mph) on sections of roadway with posted speeds between 35-40 mph. Currently, traveling by car from the western end of the project study corridor (I-695) to downtown (Pratt Street), a distance of nine miles, can take as long as 20 minutes during the peak rush hour. This would worsen by Design Year 2035 with a projected increase in traffic of 20 percent over current conditions. By 2035, it may take as long as 28 minutes to travel the same corridor during the peak rush hour, with traffic speeds ranging between 4-32 mph.


Congestion in downtown Baltimore

In the CBD and east of downtown, travel in the east-west direction is even slower and more congested. Main east-west streets such as Fayette, Lombard, Eastern, and Fleet Streets are narrow and signalized at nearly every intersection. Traffic speeds downtown range between 4-22 mph during peak travel periods on streets posted at 25 mph. Traffic through downtown and in eastern Baltimore City is projected to increase by 25-35 percent by Design Year 2035. In 2035, during rush hours, the travel time in the west-east direction from Martin Luther King, Jr. (MLK Jr.) Boulevard to Conkling Street via Fleet Street and Boston Street would increase from approximately 7 minutes currently to 12 minutes by 2035. It is also anticipated that the travel time along Lombard Street would increase from 9 minutes to 26 minutes during peak travel periods, thus worsening delays experienced today.

Buses in the project study corridor are subject to the same traffic congestion as automobiles, but have longer travel times because of frequent stops. For most bus routes, speeds during the busiest travel times average only about 9 mph. For example, current bus travel times between Edmondson Village and downtown takes approximately 27 minutes. The US 40 Quick Bus currently makes the trip in approximately 20 minutes. In 2035, the same trip on the US 40 Quick Bus would take approximately 39 minutes.

3.2 Access to Employment and Major Activity Centers

Many people live, work, shop, and visit in the project study corridor, which leads to complex travel patterns and a large need for road and transit services that function well. Many major activity centers are located along the east-west corridor. To the west are University of Maryland, University Center, the redevelopment at the West Baltimore MARC Station, and the Social Security Complex in Woodlawn; to the east are the Johns Hopkins Bayview Medical Center campus, Canton, Fell's Point, and Harbor East.

Social Security Administration office

Johns Hopkins Bayview Medical Center campus

Many residents rely on public transit to access jobs, services, and activities within Baltimore City and surrounding counties. However, it is difficult for the existing transit system to serve outlying, suburban locations. Buses must share the same congested roads with other vehicles. Sometimes, transit riders must transfer to several buses to reach their destination. In some cases, the Central Light Rail Line and Metro do not extend to the major employment areas that are developing in the suburbs. As a result, travel by transit is sometimes inconvenient and time consuming, making access to jobs and activity centers difficult without an automobile.

Despite long travel times and limited access to suburban locations, the demand for transit is high in the project study corridor. Twenty-three bus routes provide east-west service in the project study corridor, carrying over 131,600 riders per day. Four of these 23 routes (15, 20, 23, and 40) have some of the highest ridership in the MTA bus network. The US 40 Quick Bus operates throughout the project study corridor providing limited-stop service and resulting in some travel time savings (approximately 7 to 10 minutes) over local bus service. However, the US 40 Quick Bus is subject to the same roadway congestion as automobiles and other buses. The project study corridor is an area with a demonstrated demand for transit, despite the constraints to the service currently provided. (Refer to **Section 4.6** in this technical report for additional information.)

3.3 Transportation Options for East-West Commuting

Travel choices along the project study corridor are currently limited to driving on congested roads or taking a bus that travels along those same congested roads. Although bus service operates throughout the project study corridor, a high-quality transportation alternative would give east-west travelers a greater choice of travel modes. More transportation choices would help those who depend on transit while offering an attractive transportation alternative for those who generally drive but take transit for some trips.

West Baltimore MARC Park-and-ride Lot, looking east toward Franklin Street

3.4 Transit System Connections

Connectivity between modes is important in building a transit system that moves passengers efficiently and conveniently. Since public transit cannot provide direct service to each individual origin-destination, service should connect the highest density of origin destinations without transfers. Limited, convenient transfers (one at most is desirable) should also be provided to other origin-destinations.

Connections which can be made today among some transit modes include:

- MARC Camden Line and Central Light Rail at Camden Yards
- MARC/Amtrak and Central Light Rail at Penn Station
- Metro and Central Light Rail at Lexington Market or Cultural Center stations (approximately one block apart)
- Many MTA bus routes with Metro and Central Light Rail directly at rail stations

However, these connections could be improved. The Red Line project offers the opportunity for better connections between the existing MARC system, Central Light Rail, Metro, and bus service. (Refer to **Figure 1** in this technical report.)

West Baltimore MARC Station , looking west along Franklin Street

Park-and-ride lots are one type of connection linking drivers to transit. Park-and-ride lots near transit stations allow commuters to drive to a transit station, park their vehicles, and take transit to their destinations. In the case of rail services such as MARC and Metro, they also save travel time, allowing travelers to avoid traffic in particularly congested areas. Kiss-and-ride areas at stations offer safe and convenient facilities for drivers to drop off and pick up passengers at transit stations. Such facilities enable some households to reduce the number of cars needed, saving on travel expenses.

Safe and attractive pedestrian and bike paths can be important features for transit riders to access transit stops from their homes and jobs. Safe, well-lit, and weather-protective shelters and stations are also important in providing a comfortable experience for transit users as they wait for buses and trains.

It is vital that there are easy bus to bus transfers and convenient connections to Metro, Central Light Rail, and the MARC Camden and Penn Line stations within the project study corridor. Bus connections are currently available to these lines: the MARC Penn line at the West Baltimore MARC Station; the Metro at the Charles Center and Shot Tower Stations; Central Light Rail at the Camden Yards and Lexington Market Stations; and a number of local and commuter north-south bus routes.

3.5 Economic Development and Community Revitalization

The project study corridor spans various communities, with diverse economic conditions. Improved transit connections and services could encourage new development around transit stations that can revitalize surrounding neighborhoods and provide shops and other amenities that would benefit residents and commuters. Multi-use development at a transit station can provide many daily commuter needs and services without the use of a car. Market forces and other variables that are not directly related to transit strongly influence development patterns. However, improved transportation could enhance currently unrealized opportunities for growth and redevelopment within existing communities along the project study corridor.

Communities within the project study corridor that would specifically benefit from revitalization include Rosemont; the communities surrounding the West Baltimore MARC station; the communities in the vicinity of Carey and Calhoun Streets near US 40; Central Avenue; and

Highlandtown. Areas within the project study corridor that would benefit from stimulus which would encourage redevelopment or support planned development include the Security Square Mall area, Edmondson Village, Downtown, Canton, and Bayview.

West Franklin Street at Carey Street

Highlandtown Neighborhood, looking southwest along Conkling Street

3.6 Improve Air Quality

The project study corridor encompasses both Baltimore City and Baltimore County. Baltimore City is classified as a maintenance area for carbon monoxide (CO), whereas Baltimore County is classified as attainment for CO. Both areas are classified as nonattainment areas for particulate matter ($PM_{2.5}$) and as serious nonattainment areas for Ozone (O_3). Ozone is a gas formed by the combination of nitrogen oxides, volatile organic compounds, and sunlight. Particulate matter is made of the tiny particles that float in the air from industrial and residential sources and vehicle exhausts. (Refer to **Section 4.10** for additional information.)

Traffic congestion in project study corridor

According to data from the Maryland Department of the Environment (MDE), cars, trucks, buses, and other mobile sources result in emissions of nitrogen oxides and volatile organic compounds, which contribute to ground-level ozone formation. Vehicle emissions and traffic congestion also contribute to the amount of fine particulate matter. Transit can help reduce vehicle emissions because buses and trains, especially if electric, can carry passengers using much less fuel and producing fewer emissions per traveler than cars.

4. Background

The following section provides the background information and data supporting the purpose and need for the project. Additional technical reports and memorandum are cited where additional detail is available.

4.1 Transit-Dependent Populations within the Project Study Corridor

The demographic composition of the project study corridor was evaluated to determine the location of transit-dependent populations. Certain groups of people identifiable through US Census data typically have a higher degree of transit dependency. These include elderly, disabled, and low-income populations, as well as populations with no vehicle available. Refer to the *Neighborhood Effects Technical Report* for additional information on the population demographics of the project study corridor.

Elderly people are typically more transit-dependent than others because they often are no longer able to drive. In 2010, approximately 11 percent of the total population residing in the Red Line project study corridor were considered elderly (65 years or older). The elderly population is distributed fairly evenly throughout the project study corridor, with no major concentrations of elderly population occurring.

Disabled people are typically more transit-dependent than others because some disabilities prohibit people from driving. The US Census defines disabled people as those who suffer from long-lasting conditions that substantially limit one or more basic physical activities, and individuals that have a physical, mental or emotional condition that makes it difficult to perform certain activities. The most recent available data indicates that the disabled population within the project study corridor is less than the averages for the State of Maryland, Baltimore County and Baltimore City.

Low-income families are typically more transit dependent because their income does not enable them to own and maintain a car. The most recent available data indicates approximately 21 percent of the households in the project study corridor were considered low-income in 2010, approximately 2 percent of those in Baltimore County and 20 percent of those in Baltimore City. US Census tracts within the project study corridor are considered low-income for purposes of this analysis if they have a low-income population ten percentage points or more higher than the study area average (that is 31 percent or more). Census tracts in Baltimore County that meet this low-income threshold are located surrounding or directly adjacent to the stations: Rosemont, West Baltimore MARC, Harlem Park, Poppleton, Howard Street/University Center, Harbor East, Fell's Point and Highlandtown/Greektown.

People with no vehicle available are dependent on other forms of transportation, such as walking, biking or transit, to travel to desired destinations. Therefore, these people would typically have a higher dependence on transit than others. The most recent available data indicates approximately 28 percent of the people residing in the project study corridor had no vehicle available. There was a significant difference in the number of people with no vehicle available residing in Baltimore County versus Baltimore City portions of the project study corridor. Two percent of the people within the Baltimore County portion had no vehicle available, in contrast to 26 percent of the people in the Baltimore City portion. US Census tracts within the project study corridor are considered low-income for purposes of this analysis if they have a low-income population that is 10 percentage points or more higher than the study area average (38 percent or more). Census tracts in Baltimore City that meet this low-income threshold are located surrounding or directly adjacent to the following stations: Rosemont, West Baltimore MARC, Harlem Park, Poppleton, Howard Street/University Center, Harbor East, Fell's Point, Bayview Campus and Bayview MARC.

4.2 Existing Corridor Land Use

The Red Line project study corridor extends approximately 14 miles from the CMS on the west in Woodlawn (Baltimore County) to the Johns Hopkins Bayview Medical Center campus on the east (Baltimore City). Refer to **Figure 1**. The majority of the corridor falls within Baltimore City. The downtown CBD is comprised of commercial and institutional land uses, with densely developed residential areas radiating out toward the city/county boundary; refer to **Figure 2** for a map of the generalized land uses in the project study corridor.

The three-mile portion of the project study corridor in Baltimore County contains major employment centers, shopping, interstate highways, and housing. One of the region's largest employment centers, Social Security Administration, is located in the Woodlawn area. The residential development in Baltimore County is somewhat less dense compared to that of the city. Traveling east towards the city line, residential densities increase where the pattern of development resembles a grid. Leakin Park and Gwynns Falls Park, large city-owned resources, lie just within the city limits, north of the corridor. Moving toward the downtown area, the corridor connects the West Baltimore MARC Station, schools, and shopping centers, all within residential neighborhoods.

The CBD is a major employment center for government, healthcare, and businesses. It includes not only the Inner Harbor, a nationally-known tourist destination, but it is also home to major league baseball, football, indoor soccer teams, universities and professional schools, hospitals, government agencies, and many financial institutions. The CBD has recently also become a residential area and offers a number of opportunities to connect with MARC, Metro, Central Light Rail, and the MTA core bus system.

Moving toward the eastern portion of the corridor, the Fell's Point and Canton areas are undergoing intense infill development, creating even greater residential density and numerous business opportunities. The easternmost edge of the corridor is comprised mostly of industrial and institutional uses, including the Johns Hopkins Bayview Medical Center campus.

Refer to the *Land Use, Zoning and Public Policy Technical Report* for additional information.

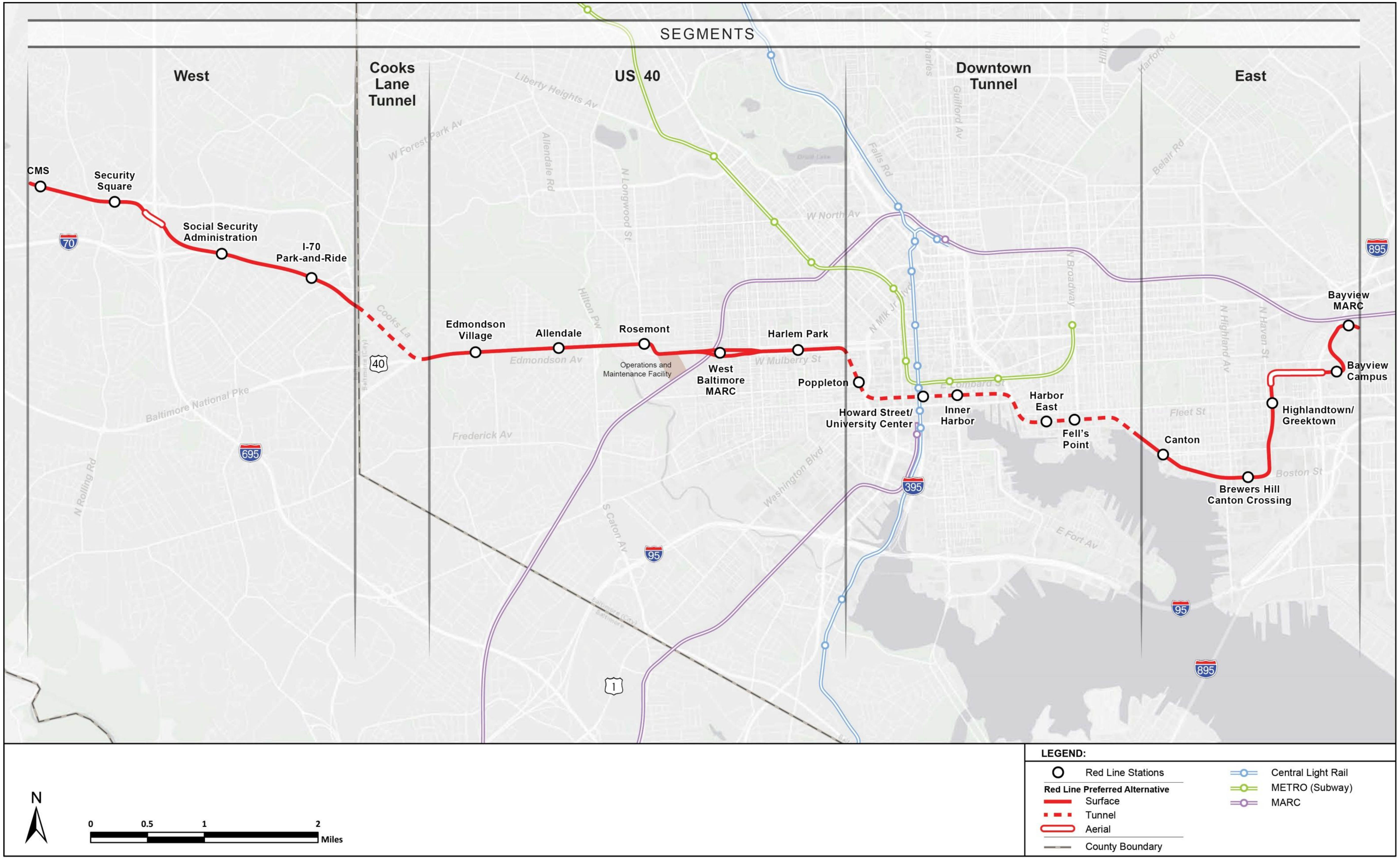


Figure 1: Red Line Preferred Alternative

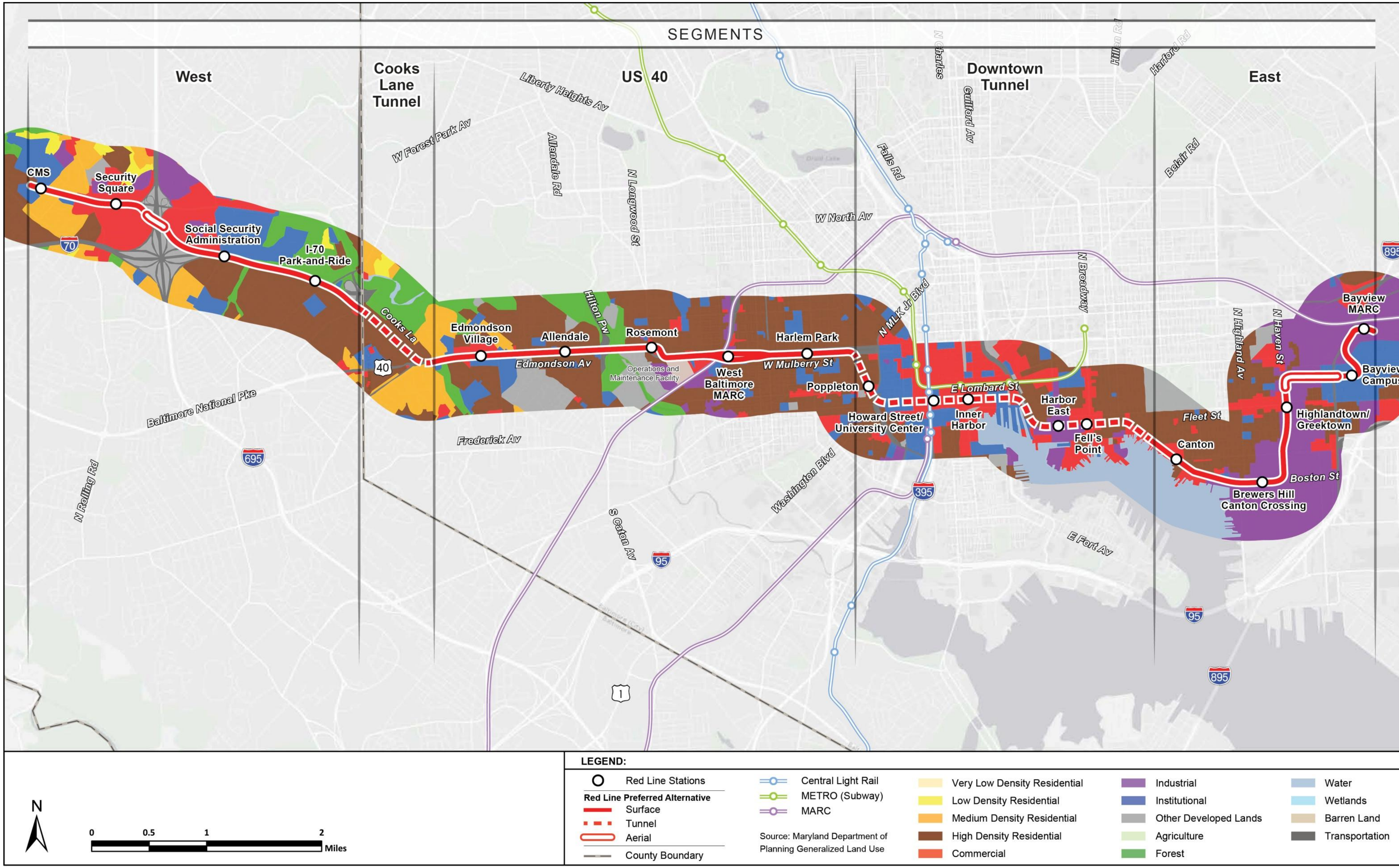


Figure 2: Generalized Land Use in the Project Study Corridor

4.3 Planned and Programmed Development

Major development projects that are currently planned or underway within the project study corridor are summarized below by segment (refer to **Figure 1** of this technical report for the segment limits within the project study corridor). Refer to the *Land Use, Zoning and Public Policy Technical Report* for additional information.

4.3.1 West Segment

Development plans within the West segment include the subdivision of four small residential lots, resulting in nine additional dwelling units and new construction of a warehouse, hotel/motel, 16-unit apartment building, two 121,000-square foot office buildings and three office buildings ranging from 18,000 to 36,000 square feet.

4.3.2 Cooks Lane Tunnel Segment

There are no development projects under construction, approved, or planned within the Cooks Lane Tunnel segment.

4.3.3 US 40 Segment

The US 40 segment contains one significant development project which is currently under construction. When complete, the Uplands residential development would occupy 100 acres and contain 1,100 mixed income dwelling units.

4.3.4 Downtown Tunnel Segment

The Downtown Tunnel segment contains several development projects. Beginning in the west, near the Poppleton Station, there are two development projects: one 22,000-square foot residential complex and a 200,000-square foot University of Maryland cancer treatment center. Farther east there are plans to construct a multi-use development with 1,800 dwelling units and 100,000 square feet of retail space. Plans to construct a 203,000-square foot commercial lab and office building for the University of Maryland have been submitted for approval.

In downtown Baltimore, near the Inner Harbor station, there are five approved projects that are currently on hold: three hotel projects (ranging from 150 rooms to 300 rooms); one 100 unit hotel/residential project; and a mixed-use redevelopment of the former Mechanic Theater containing a 120,000-square foot hotel, 100,000 square feet of retail, and a 250,000-square foot residential component. In the Harbor East Station area, an approved 1.8-million square foot office and retail complex is planned. In the Fell’s Point Station area near the Broadway Market there is an approved 155-dwelling-unit project approved. Approved, but on hold, is a 92,700-square foot, 130-room Aloft Hotel, a 725-dwelling-unit residential project, and a mixed-use 284-dwelling-unit and 13,000-square foot retail project.

Also near the Fell’s Point station, the Union Wharf residential complex is under construction. The development contains 280 dwelling units and is expected to be completed by 2014. Also near the Fell’s Point Station, there is a 100-unit apartment project planned.

4.3.5 East Segment

Within the East segment there are several proposed development projects. Adjacent to the Brewers Hill/Canton Crossing Station, there is a large mixed-use development project that is ongoing. The Brewers Hill project is expected to be a total of 1.9 million square feet and include 430 dwelling units, 600,000 square feet of retail space, and 650,000 square feet of office space.

Also near the Brewers Hill/Canton Crossing Station there are three approved projects. One project would have between 220 and 440 apartments and between 5,000 and 19,000 square feet of retail space. Another is a 480,000-square foot mixed-use shopping center, and the third project is a 700-space parking garage.

East of the Highlandtown/Greektown Station is a 17.9 acre residential development site. Approximately 4.5 acres of the site are partially built. Near the Bayview Station, the National Institute of Health is constructing 5 million square feet of new office space.

4.4 State, City and County Land Use and Zoning Initiatives

The following section summarizes the current state, city and county land use and zoning initiatives. Refer to the *Land Use, Zoning and Public Policy Technical Report* for additional information.

4.4.1 State

The entire Red Line project study corridor falls within a Priority Funding Area and is therefore an area to which the State, Baltimore City and Baltimore County would direct growth and redevelopment.

In 1997, Maryland's General Assembly adopted the Smart Growth Areas Act which provides financial incentives to locate development in established activity centers, many of which are served by regional transit, over greenfield locations. The State, through the Maryland Department of Transportation (MDOT), has taken an active role in generating both public and private sector interest in Transit Oriented Development (TOD) projects focusing new development near transit stations that is designed and constructed to support transit and neighborhoods in need of restoration, redevelopment and revitalization.

4.4.2 Baltimore City

In 2008, Baltimore City began to rewrite the zoning code in line with current and anticipated land use needs. As part of the city-wide zoning code revision effort, TransForm Baltimore: The Zoning Code Rewrite, current zoning districts would be redefined to more strongly encourage mixed-use development and more specialized zoning districts and regulations, such as TOD. The Department of Planning is revising the Code based on comments received and would present revised text and maps to the City Council for introduction, hearings and approvals. This process is anticipated to be completed by the end of 2012.

Baltimore City's Comprehensive Plan outlines the City's goals to provide livable, walkable, transit-friendly areas. The Comprehensive Plan is organized around four themes: "Live, Earn, Play and Learn". As summarized below, two of the "Live" goals are related to transit and encourage development to occur near transit.

- Live Goal 2: Elevate the Design and Quality of the City's Built Environment
    - Objective 3 (of 5): Promote TOD and Mixed-use Development to Reinforce Neighborhood Centers and Main Streets
        - Strategy 1 (of 4): Implement a Transit Oriented Development (TOD) strategy to foster stronger neighborhood centers
        - Strategy 2 (of 4): Provide preferential capital funding for TOD projects
        - Strategy 3 (of 4): Create mixed-use with residential zoning category
        - Strategy 4 (of 4): Ensure all residents are within 1.5 miles of quality groceries and neighborhood services
- Live Goal 3: Improve Transportation Access, Accessibility and Choice for City Residents
    - Objective 2 (of 2): Facilitate Movement throughout the Region
        - Strategy 2 (of 5): Support efforts to implement the Baltimore Regional Rail Plan and its Red and Green Line priority segments

4.4.3 Baltimore County

To reflect the need for TOD near the Red Line, Baltimore County re-zoned the Security Square Mall area to BM-CT, a "town center" designation allowing mixed-use.

Baltimore County's planning strategy is to direct future growth within the Urban-Rural Demarcation Line (URDL). In 1967, the County delineated two distinct land management area: the urban area and the rural area with the URDL. The portion of the Red Line project study corridor located within Baltimore County is within the URDL.

4.5 Employers and Potential Transit Markets

The following section summarizes the current employers in the project study corridor and describes four potential transit markets that could be served by the Red Line.

4.5.1 Employers

The Baltimore Metropolitan Council (BMC) projects the region would experience an increase in 451,600 jobs by 2035, reaching a total of nearly 2 million jobs. There are approximately 7,500 businesses located within the project study corridor, employing over 192,000 people (BMC, 2002). The largest proportion of businesses are in the service industry, with the remaining largest portions in retail; finance, insurance, and real estate; and government services. The majority of businesses are small, with 20 or fewer employees, to medium sized, with 21 to 99 employees. However, while large business with over 100 employees only make up a small number of overall employers within the project study corridor, over 120,000 employees work at large businesses. Multiple business centers and institutions within the project study corridor employ over 1,000 people, including:

- CMS;
- Social Security Administration;
- University of Maryland;
- Office centers in downtown Baltimore and Harbor East; and
- Johns Hopkins Bayview Medical Center.

Additionally, several clusters of medium and large sized businesses are located within a few blocks of the Preferred Alternative station locations.

4.5.2 Potential Transit Markets

The Red Line would serve people who want to travel east-west within the project study corridor. However, as part of a larger network, the Red Line also can serve many more people living or working outside of the project study corridor. Four distinct travel markets would directly benefit from transportation improvements within the project study corridor:

1. Residents of the project study corridor traveling to downtown as their final destination, or transferring from the transit services that link to regional destinations such as BWI Airport, Aberdeen Proving Grounds, and Washington DC.
2. Commuters headed into the Red Line project study corridor from the east or west. West of the corridor, this includes commuters from the I-70 corridor, including northern Howard County and southern Carroll County, and those areas served by the Baltimore Beltway (I-695), including the Liberty Road and Rolling Road corridors and the Catonsville area. Commuters headed downtown from eastern Baltimore County and Harford County enter the corridor via I-95, I-895, Eastern Avenue, Pulaski Highway/US 40, and Dundalk Avenue.
3. Reverse commuters to the large Social Security Administration complex in Woodlawn, the CMS processing center, Security Square Mall, and surrounding businesses coming from residential areas in Baltimore City.
4. Commuters, patients and visitors headed to the many hospitals and other medical centers in the Red Line project study corridor.

Other travel markets would benefit as well, as the Red Line would connect with two MARC stations (West Baltimore MARC and proposed Bayview MARC), the Central Light Rail (which runs along Howard Street downtown), and at least two downtown Metro stations (Charles Center and Shot Tower), providing new transit connections between destinations throughout the region, including BWI Airport and Washington, DC.

a. Residents Traveling to Downtown

Downtown contains a wide variety of attractions, which draw in travelers from near and far in every direction. These attractions include jobs, government offices, museums, libraries, colleges, hospitals, restaurants, shopping, theaters, sports arenas, the convention center, and the Inner Harbor entertainment district. Travelers also head downtown to transfer to MARC, the Metro, Amtrak, the Central Light Rail, and local or long-distance bus services. The Red Line would also serve the tourists and special events in downtown.

Although the BMC *Plan It 2035* projects that the percentage of people using transit to get to work would remain constant at around 8 percent, there is a need to reduce the number of trips by vehicles with only one person inside, also known as single occupancy vehicles. The number of trips made by single occupancy vehicles into the CBD leads to congestion that affects buses and other vehicles that must travel along the same roads. As the on-going downtown revitalization spreads east to Fell's Point, Canton, and west to the University of Maryland area, the downtown population and workforce would continue to expand and require enhanced mobility in the Red Line project study corridor.

b. Commuters from Surrounding Areas

Travel demand to suburban residential and employment locations has increased in the region. These outlying locations make it increasingly difficult for the existing transit service to serve these dispersed outlying locations. The BMC's population estimates anticipate employment in suburban jurisdictions of the Baltimore Region to increase by 29 percent by 2035.

Residents of areas along the I-70 and I-695 corridors on the west, as well as commuters from the east, would be able to take advantage of the Red Line improved transit to travel downtown. The availability of transit service that could travel faster than regular traffic would allow drivers to park at park-and-ride lots near stations on the western or eastern end of the corridor, and take a fast transit trip to downtown, instead of wasting time and fuel traveling along existing highway routes to downtown.

c. Reverse Commuters to SSA, CMS, Security Square Mall, and Surrounding Businesses

Travel demand to suburban residential and employment locations has increased in the region. The BMC projects that the traditional pattern of work trips starting in the suburbs and going into the city would be replaced by a pattern of work trips going from one suburb to another. Currently, transit does not effectively serve major suburban employment centers in the Baltimore region, making access to jobs difficult without an automobile.

Total employment along Security Boulevard is over 32,000 today. This is expected to grow to over 40,000 jobs by the year 2035. Transit improvements in the Red Line project study corridor would connect to the Social Security Administration and other employment centers in western Baltimore County providing Baltimore City residents with travel options for accessing jobs and public services in this area without using a car.

d. Medical Facilities

Transit improvements would benefit the many hospitals and health care facilities in the project study corridor by providing faster travel times during commuter peak periods, as well as in other ways. Many hospitals have limited parking, or set aside too much land and other resources for parking facilities. Increasing the number of visitors, patients and staff who arrive by transit would free up these resources for use in health care. In addition, patients who cannot drive after a medical procedure may need transit. Transit can also be a vital connection for transit dependent patients and visitors.

Medical facilities operate around the clock, and generate a large number of trips each day. As an example, the Johns Hopkins Bayview Medical Center campus, which includes the hospital, research facilities, and doctor's offices, has over 6,000 employees who serve 500,000 patients each year. Add visitors and deliveries, this becomes a destination for thousands of trips each day. Trips would increase in the future, as total campus employment is expected to reach over 12,000 by 2035.

4.6 Public Transit

The following section describes the existing public transit system in the Baltimore Region, followed by the existing transit service provided within the project study corridor. This section concludes with a summary of the current and future transit performance. Refer to the *Public Transportation Technical Report* for additional information.

4.6.1 Existing Public Transit in the Baltimore Region

The existing public transit service in the project study corridor is largely provided by fixed-route, fixed-schedule buses operating in mixed traffic on local streets; and rail service, specifically the Central Light Rail Line, Metro (heavy rail), and MARC (commuter rail). (Refer to **Figure 1** of this technical report.) The MTA operates six types of local and regional transit services: Local Bus, Commuter Bus, Metro, Central Light Rail, MARC, and Paratransit (Mobility) services, with annual ridership among all six types of over 104 million in FY 2010.

The MTA provides 56 local and express bus routes that travel throughout Baltimore City, and Baltimore and Anne Arundel Counties with average daily ridership of 232,000. These routes include major radial routes, cross-town routes, circumferential routes, and local circulator routes. In addition to local and express bus service, the MTA provides five commuter bus lines that connect Baltimore City with surrounding Maryland counties. The commuter bus service operates from select park-and-ride locations with over 1,300 average daily trips. In total, the sixty-one MTA bus lines served over 71.0 million passengers in FY 2010.

MTA's Metro travels in a northwest-to-southeast direction from Owings Mills in Baltimore County to downtown Baltimore City, continuing northeast from downtown to the Johns Hopkins Medical Center complex in east Baltimore City. The 15.5-mile system provided service to over 13 million passengers in FY 2010. The Metro operates in a combination of tunnel, aerial, and exclusive surface sections. A one-way trip from end-to-end along all 14 stations takes approximately 30 minutes.

The existing Central Light Rail operates north-south across the Red Line corridor from Hunt Valley in Baltimore County to Baltimore-Washington International Airport (BWI) and Glen Burnie in Anne Arundel County. The Central Light Rail also provides direct service to Amtrak's Penn Station in Baltimore City on select trips. The Central Light Rail is 30 miles in length with 32 stations located along the line, many of which have parking available or are designed to include access to connecting bus lines. The Central Light Rail carries over 8 million passengers each year.

MARC provides commuter rail service along two railroad corridors in the Baltimore region – the Penn Line and Camden Line. The two lines carried over 8 million riders in FY 2010, most of whom were going to Washington DC or to Baltimore City. There are three MARC stations in Baltimore City: Camden Station, West Baltimore Station, and Pennsylvania Station. Like most suburban MARC stations, these downtown MARC stations have park-and-ride lots.

For transit riders who have a disability, the MTA provides paratransit services to supplement the core transit services. The MTA transports nearly 1.2 million passengers each year in lift-equipped mobility vans, vans, and sedans. In addition, the MTA provides taxi vouchers to eligible disabled riders for trips through approved taxi operators. Approximately 272,000 taxi trips were provided in FY 2010.

4.6.2 Public Transit in the Red Line Corridor

There is a high density of existing transit services within the project study corridor. Twenty-three bus routes (Routes #1, 7, 10, 11, 13, 15, 16, 20, 21, 22, 23, 24, 30, 38, 40, 44, 47, 51, 57, 77, 99, 150, and 160) provide bus service within the corridor and serve over 131,600 riders per day. These 23 routes (shown in **Figure 3** of this technical report) do not include any other MTA bus routes that cross through downtown perpendicular to the Red Line.

Four of the 23 routes (15, 20, 23, and 40) are among the highest ridership bus routes in the MTA bus network. Route 15, which serves the Social Security Administration and Security Square Mall, and runs to downtown Baltimore (with some service continuing on to Perry Hall and White Marsh), is one of the highest ridership bus routes, with an average of over 16,000 trips every weekday. Route 20 travels the corridor between Security Square Mall and Dundalk along Baltimore and Fayette Streets, a few blocks south of Routes 23 and 15. Route 20 averages 12,000 trips each day. Route 23, which closely follows the route of the Preferred Alternative, operating along the east-west corridor serving the Edmondson Village area to the Johns Hopkins Bayview Medical Center campus, has an average weekday ridership of over 13,000. MTA's Quick Bus 40 has been in operation for only a few years, but has become a very successful bus line for the MTA, with an average daily ridership of over 11,000. The route closely follows the project study corridor, providing frequent, limited-stop service from Security Square Mall through downtown to the Johns Hopkins Bayview Medical Center campus, continuing to the Essex park-and-ride lot and further east along Eastern Avenue.

While the project study corridor contains an extensive bus network serving east-west travel, for those traveling east and west in the project study corridor, bus service can be slow. Buses operate on local streets, which are subject to the same traffic signals and traffic congestion as other vehicles. The fact that ridership is so high in the project study corridor despite slow speeds emphasizes the strong transit market in this corridor.

Metro, Central Light Rail, and MARC serve the project study corridor on north-south routes (**Figure 1**). Generally rail transit service does not serve east-west trips along the corridor, other than Metro's subway section, which serves some east-west trips through downtown.

4.6.3 Current and Future Transit Performance

Existing transit services in the Red Line project study corridor fare no better than automobile travelers as the buses are subject to the same traffic congestion and slow travel speeds. In addition, substandard lane widths and poor road conditions in the curb lane result in poor bus ride quality.

Buses operating on US 40/Edmondson Avenue average less than 11 mph over the majority of their route due to frequent stops and traffic congestion. Automobile speeds on this road range from 10 to 30 mph depending on location. Buses, with their frequent stops, have longer travel times than other vehicles. This results in long commutes for transit passengers from the corridor headed downtown, as well as for reverse commuters to the Social Security Administration complex and area businesses. For example, current transit travel times during the peak-period on the US 40 Quick Bus between Edmondson Village and Baltimore Street and Charles Street intersection downtown is approximately 20 minutes. The same trip in 2035, according to the regional model, would take approximately 39 minutes as a result of traffic congestion.

The reasons for choosing automobile travel over transit are personal and vary from household to household. These reasons can include: decreased speed or service levels on transit, increased incomes (making automobile ownership and travel more affordable), and travel destinations that are not easily accessible by transit.

If no improvements are made to east-west transit service in the project study corridor, future transit service levels would likely be similar to today's, with travel times likely longer because of the projected increase in traffic.

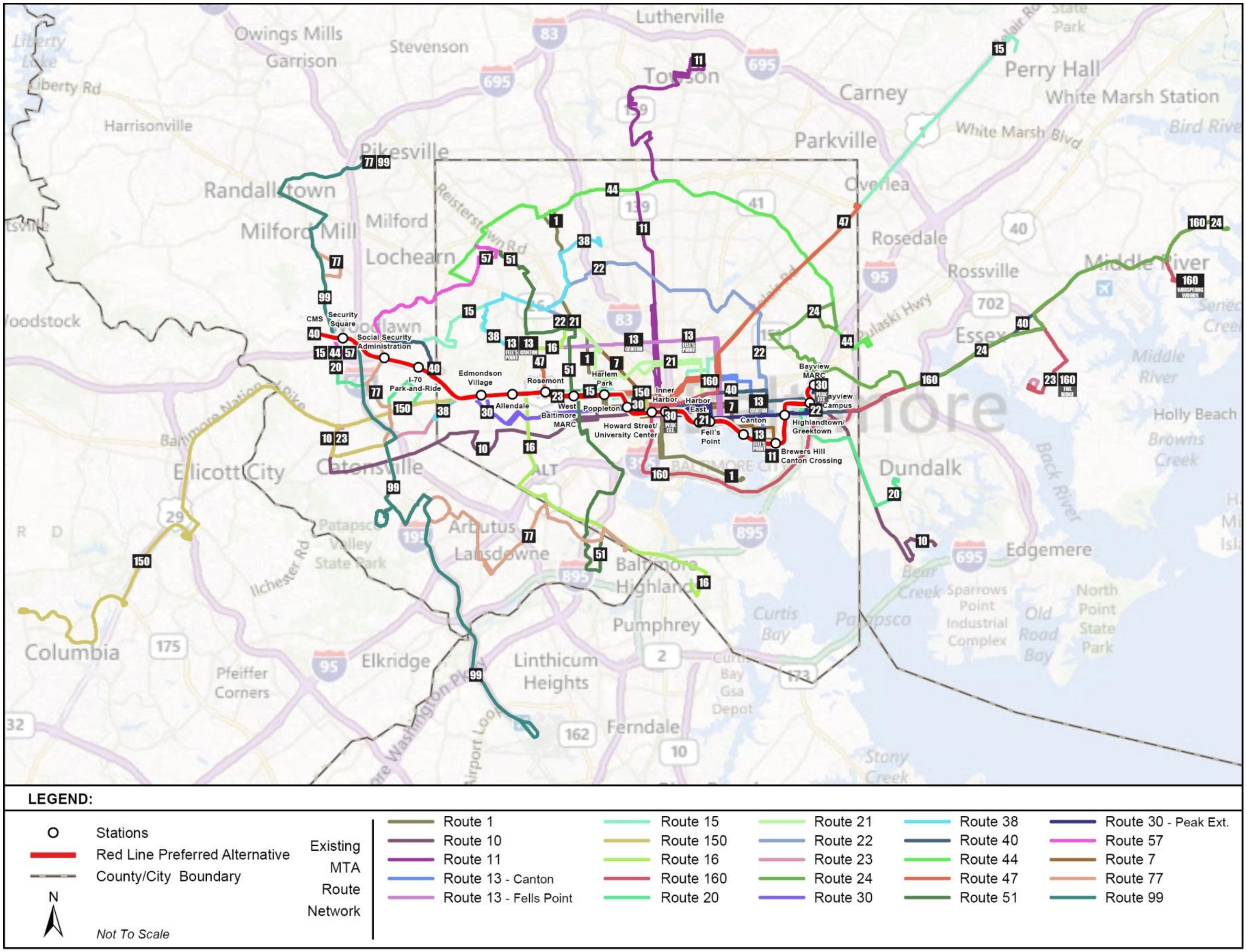


Figure 3: Existing Transit Service in the Project Study Corridor

4.7 Project Study Corridor Roadways

The following section describes the existing roadways within the project study corridor, as well as summarizes the current (2011) conditions and projected roadway performance in 2035 based on travel demand forecasts. For additional information on existing roadway conditions and traffic analysis conducted for the project refer to the *Traffic and Parking Technical Report*.

4.7.1 Existing Roadways

I-695 is a beltway around Baltimore. It bisects the Red Line project study corridor on the west side. The major east-west roads in the corridor are:

- I-70 is a major interstate which terminates at a park and-ride lot about two miles east of I-695.
- US 40 enters the project study corridor from the west as the Baltimore National Pike. It merges into Edmondson Avenue, and turns on Franklin Street before traveling along a section of road that was originally constructed to be part of an extended I-70. Through downtown, US 40 splits into two one-way roads, Franklin Street and Mulberry Street, before combining back into Orleans Street. US 40 becomes Pulaski Highway as it heads northeast out of the corridor.
- MD 122 (Security Boulevard) parallels I-70 to the north to serve the large CMS and Social Security Administration areas on both sides of I-695, as well as providing access to Security Square Mall.

The major north-south roads in the project study corridor are:

- I-895 travels through Baltimore in a northeast-southwest direction, bisecting the Red Line project study corridor near the Johns Hopkins Bayview Medical Center on the east side. I-895 crosses under the Patapsco River through the Harbor Tunnel.
- I-395 branches off I-95 to provide direct access to downtown Baltimore.
- I-83 is an interstate roadway from the north that terminates at the Baltimore CBD on President Street.
- US 1 is a major road from the northeast to southwest that traverses the corridor west of the Baltimore CBD. US 1 has a one-way pair of lanes through the corridor, traveling on Fulton Avenue and Monroe Street, both of which are two lane roads.

Major downtown thoroughfares include:

- President Street is a four to six lane road and the terminus of I-83. It is a two-way street, which runs in a north-south direction and provides a connection to Eastern Avenue and Fleet Street.
- Charles Street is a two to four lane street that runs in a north-south direction through the heart of the CBD, then continues north of downtown. It is one-way northbound through the project study corridor.
- Central Avenue is a two-lane, two-way street that runs in a north-south direction.
- Broadway is a multi-lane, two-way street that runs in a north-south direction.

- Baltimore Street is a three to four-lane street that runs one-way in the eastbound direction. It has restricted parking in the curb lanes between MLK Jr. Boulevard and President Street and two lanes traveling in both directions east of President Street.
- Lombard Street has two to six lanes that travel one-way in a westbound direction.
- Fayette Street is a two to four lane street that mainly travels one-way in a westbound direction.
- Pratt Street has two to six lanes that travel one-way in an eastbound direction.

Other important roadways in the project study corridor include:

- Cooks Lane is a two-lane, two-way residential street with on-street parking. It is critical to traffic movement in the project study corridor, serving as a key link between I-70 and US 40/Edmondson Avenue.
- Rolling Road is a four-lane north-south roadway located near the far western side of the Red Line project study corridor. This roadway provides a parallel route to I-695 on the west side.
- MLK Jr. Boulevard: I-395 exits onto this six-lane, north-south road on the west side of the CBD.
- Eastern Avenue is an east-west road that travels from the Inner Harbor to the eastern end of Baltimore County. It is MD 150 along much of its length. I-95, I-895 and I-695 (east) each have exits on Eastern Avenue, providing important links to downtown. Within the project study corridor, two of Eastern Avenue's four lanes are used for parking.
- Fleet Street is a two-way road that travels east-west from the Inner Harbor to Bayview. It is not continuous due to the rail tracks paralleling I-95. Parking is allowed on two of the street's four lanes because of the lack of available off-street parking in this older section of Baltimore.
- Boston Street is a four-lane two-way road that serves as a key entryway to the Canton area.

The current transportation network in the western portion of the project study corridor does not adequately address the existing demand for travel between I-70 and downtown Baltimore. The presence of high-density residential neighborhoods and sensitive resources (such as large parks and cemeteries) make it difficult to provide an efficient transportation network in the corridor. The original interstate highway plan for Baltimore included the continuation of I-70, the major connecting freeway from the west, into downtown. In anticipation of the extension, a 10-block section of western downtown Baltimore was razed, displacing hundreds of residents. In its place, a six-lane freeway was planned to connect with the future I-70. A short segment of highway was constructed but the planned extension was abandoned partly because it would have traveled through Leakin Park and Gwynns Falls Park, both of which are considered prime parkland. Since the highway also would have traveled through established residential neighborhoods, the connecting link between I-70 and downtown was never completed. Today, I-70 ends approximately 2 miles east of I-695 and about five miles from the CBD.

Without a major connecting link between I-70 and the CBD, motorists are forced to use US 40 from the west. US 40 is generally a six-lane divided road, with narrow lanes and a posted speed of 30 mph. Four roads and their corresponding traffic merge onto US 40 west of Edmondson Village; traffic from Security Boulevard and I-70 via Cooks Lane; traffic from US 40 west from western Baltimore and Howard County; and traffic from Edmondson Avenue, serving northern Catonsville.

Where these four road networks meet, current traffic is 39,000 vehicles per day, leading to reduced speeds and delays during morning and afternoon rush hours. It is projected that daily traffic on US 40 would rise to 46,000 vehicles per day in 2035, leading to increased congestion and delay. As US 40 moves into downtown Baltimore, the road network becomes a one-way grid pattern with numerous traffic signals between short blocks. Traffic volumes are high, leading to slow travel speeds. Vehicles trying to move through road intersections are hindered by the high demand along both north-south and east-west travel routes.

East of downtown Baltimore, I-95 skirts south of the CBD. Motorists from the heavily residential northeast suburbs accessing I-95 must decide between using congested US 40 or lesser arterial and city streets, including Eastern Avenue and Fleet Street, both of which are two-way streets with one-lane operating in each direction or substantially increasing their travel distance by going through one of the tunnels. Eastern Avenue, which becomes MD 150, provides a direct link to downtown from I-95, I-895, and I-695. Even with only one lane operating in each direction, Eastern Avenue and Fleet Street each carry about 20,000 vehicles per day.

Other streets on the east side, such as Boston Street, are experiencing traffic growth both due to the redevelopment of the Canton area and more trips into the growing downtown area. This creates congested traffic conditions that result in an increased cost of doing business along the respective routes and, for residents, a diminished quality of life due to longer travel times.

The Johns Hopkins Bayview Medical Center campus is served by Lombard Street. Additional interchange movements have recently been provided from I-895 to Lombard Street to increase access to the area. Motorists from the CBD must use many of the local streets to access the Bayview area.

4.7.2 Current and Future Highway Performance

Travel demand forecasts were developed for several roadways in the project study corridor. Average daily traffic is projected to increase along all but one of the 18 roadway locations evaluated under the No-Build scenario. Percentages of projected growth are summarized in **Table 1**. Areas with the greatest projected increase in growth (over 50 percent) are: MLK Jr. Boulevard; Lombard Street (west of Greene Street and west of Market Place); Boston Street; Interstate Avenue; and Bayview Boulevard.

Table 1: Change in Average Daily Traffic (existing-2035), under No-Build Condition

Location	Percent Growth	Location	Percent Growth
I-70, East of I-695	38%	Lombard Street, west of Market Place	62%
Security Boulevard, west of I-695 to Rolling Road	1%	President Street, north of Lombard Street	-1%
US 40 from Rolling Road to Cooks Lane	21% to 30%	Fleet Street, east of President Street	10%
Edmondson Avenue, from Cooks Lane to Hilton Parkway	18% to 17%	Boston Street, north of Montford Avenue	33%
Frederick Avenue, west of Hilton Drive	13%	Boston Street, east of Conkling Street	56%
Franklin Street, east of Franklintown Road	21%	Interstate Avenue, east of I-95 ramps	82%
MLK Jr. Boulevard, south of Pratt Street	51%	O'Donnell Street, east of Conkling Street	44%
Lombard Street, west of Greene Street	60%	Eastern Avenue, east of Bayview Boulevard	2%
Lombard Street, east of Charles Street	15%	Bayview Boulevard, south of Alpha Commons Drive	178%

Peak-period congestion is present throughout the project study corridor. Beginning on the west side, a number of highways converge from the west as they head downtown. Cooks Lane is a two-lane road with on-street parking. During peak-periods, traffic from two major roads, I-70 and Security Boulevard, feeds into this two-lane road that connects to US 40, making Cooks Lane congested.

US 40 is congested with traffic from Cooks Lane joining Baltimore National Pike/US 40 traffic headed east. The road width and right-of-way along US 40 itself narrows as it enters an older part of Baltimore. This portion of the corridor, US 40 from Edmondson Village to Rosemont, is largely residential, with older rowhouses fronting the street. Narrow sidewalks, utility poles immediately adjacent to the street, front steps of residences located against the sidewalk in some areas, high pedestrian volumes, on-street parking during off-peak hours, and the presence of numerous cross streets, many of them signalized, all result in slow travel speeds and long travel times along this portion of US 40.

The heavy traffic congestion and slow travel speeds discourage many west-side commuters from using US 40. These drivers instead use I-695 and I-95 to access downtown via I-395, adding to the heavy traffic already clogging those highways.

Even with the widening of I-695 and the implementation of the other planned and programmed road improvement projects, the western half of the corridor would still have to support growing amounts of future traffic. US 40 west of Cooks Lane currently carries 24,000 vehicles and US 40/Edmondson Avenue east of Swann Avenue currently carries 39,000 vehicles. Future traffic growth on US 40 west of Cooks Lane is projected to increase 21 percent (to 29,000 vehicles) and projected to increase 18 percent on US 40 east of Swann Avenue (to 46,000 vehicles).

Downtown Baltimore is congested due to the high traffic volumes and the demand for both north-south and east-west travel, causing slow speeds on all major streets. Large numbers of vehicles making turning movements in this densely developed part of the project study corridor also contribute to delay. By 2035, Lombard Street east of Charles Street is expected to carry about 15 percent more traffic than today, from 30,000 in 2011 to 34,500 in 2035.

On the east side of the project study corridor, relatively large numbers of vehicles traveling on low-capacity roads cause congestion. For example, Fleet Street east of President Street currently carries 21,000 vehicles and is projected to increase to 23,000 vehicles in 2035, a 10 percent increase. Fleet Street allows parking with peak-hour, peak direction restrictions on both sides of the street due to the lack of driveways and off-street parking available in the area. On Boston Street, east of Conkling Street, currently carries 16,000 vehicles and in 2035 is projected to carry 25,000 vehicles, a 56 percent increase.

The closely-spaced intersections, numerous traffic signals, narrow lanes, and only one lane operating in each direction causes slow traffic speeds along Fleet Street and Boston Street. Vehicles that need to make left turns or park cause slower speeds and increase delays, as there is no safe way to move past these vehicles. Vehicle speeds and travel times would be even slower in the future than today, not only due to the residential and commercial development that is underway, but also from the expected growth in travel to downtown.

Level of service (LOS), a measure of traffic congestion, was analyzed for the existing (2011) and future 2035 No-Build scenario to determine how traffic operates in the project study corridor. A rating scale, using the letters A through F, describes the amount of delay of congestion that drivers experience. Like the grading scales used in schools, A is the best and F is the worst. The letter A represents free flowing traffic conditions through the letter F, which represents stop-and-go traffic conditions.

A total of 152 intersections (132 signalized and 20 unsignalized) were analyzed for the 2035 No-Build scenario to determine AM and PM peak hour LOS. There are eight new intersections (seven signalized and one unsignalized) that would be built by 2035 along the project study corridor under the No-Build scenario. **Table 2** below provides the total number of intersections that are operating at acceptable LOS (LOS D or better) and worse (LOS E or F) in the Existing and 2035 No-Build conditions during the AM and PM peak hours.

Table 2: Summary of Existing and 2035 No-Build Levels of Service

Intersection Type	Number of Intersections Existing/ No-build	Existing[1]		No-Build[1]	
		Acceptable LOS (LOS D)	LOS E or F	Acceptable LOS (LOS D)	LOS E or F
Signalized	125/132	120 (115)	5 (10)	113 (106)	19 (26)
Unsignalized (worst approach)	19/20	16 (15)	3 (4)	12 (12)	8 (8)

Note: [1]AM (PM) peak hours
Source: MTA, 2012

The results of the 2035 No-Build analysis showed that the overall level of service would decrease over the existing conditions throughout the entire corridor, as a result of traffic volume growth in the region between 2011 and 2035. It is anticipated that all intersections that are failing in Existing Conditions would continue to fail in the future No-Build conditions with improvements as listed in the *Plan It 2035*.

4.6 Bicycles and Pedestrian Facilities

Sidewalks providing adequate pedestrian connections are available along most arterial streets within the project study corridor. However, sidewalks are not provided on one or both sides of the street along portions of several major roads, as identified in detail in the *Pedestrian and Bicycle Technical Memorandum*. The major roads without sidewalk facilities include portions of Security Boulevard, Perimeter Drive, Parallel Drive, Forest Park Avenue, Uplands Parkway, North Franklintown Road, West Mulberry Street, Boston Street, South Haven Street, and East Lombard Street. Existing pedestrian controls including signals and crosswalks were also inventoried and evaluated in order to identify pedestrian crossings that may be deficient.

Although the law allows bicyclists to operate on most streets in Baltimore County, there are five designated on-street bicycle facilities in the Baltimore County portion of the project study corridor located on: Hilton Avenue, connection to No. 8 Trolley Path, Frederick Road, Edmondson Avenue, and Montrose Avenue.

Although Baltimore City has designated on-street bicycle facilities, nearly all arterial streets in the City are used as undesignated bicycle routes. When space does not exist for bike lanes, “Share the Road” signs are installed to remind motorists that bicyclists may be present. Bicyclists are encouraged to use the shoulder of the road, or travel to the right while avoiding “door zones” and roadside hazards. There are on-street bicycle facilities concentrated in the eastern section of Baltimore City: along East Lombard Street (and west to Greene Street), East Pratt Street (and west to Greene Street), President Street, Central Avenue, South Caroline Street, South Broadway, Boston Street, Aliceanna Street, Fait Avenue, Fawn Street, Bank Street, Gough Street, East Baltimore Street, South Highland Avenue; South Conkling Street, and East Monument Street.

Shared-use paths are off-street facilities, which are paved to accommodate more than one type of user including pedestrians, bicyclists, and other non-motorized users. Existing shared-use facilities in the Baltimore County portion of the project study corridor include No. 8 Trolley Path, Short Line Rail Trail, and No. 9 Trolley path. In addition to these, the Gwynns Falls Greenway Path in Baltimore County would serve a large portion of western Baltimore County while also connecting to and extending the Gwynns Falls Trail in Baltimore City, which in turn would connect to the BWI Trail in Anne Arundel County.

Baltimore City's shared-use facilities include the Baltimore Waterfront Promenade, the Heritage Walk, the Pennsylvania Avenue Heritage Trail, and the Mount Vernon Cultural Walk. The shared-use-facilities in Baltimore City mainly consist of trails that are separated into various segments including: Gwynns Falls Trail and extension, Herring Run Trail, Inner Harbor Connector, Inner Harbor Promenade, Jones Falls Trail and Stoney Run Trail.

4.7 Planned and Programmed Transportation Projects

The 2011 Baltimore Regional Transportation Board's Constrained Long Range Plan (CLRP), *Plan It 2035* includes the existing highway and transit network, as well as planned and programmed (committed) transportation improvements for transit service levels, highway networks and traffic volumes, and forecasted demographics for the year 2035. The regional transit and highway projects and the local projects within the study corridor that are included in the CLRP are summarized in **Table 3**.

Table 3: 2035 Planned and Programmed Transportation Improvements

Facility	Location	Description
Transit Projects		
Bayview MARC and Intermodal Station	Lombard Street at Bayview Boulevard	New station to connect with Red Line
MARC Camden Line	MARC Growth and Investment Plan Improvements	Capital Investment through 2020
MARC Green Line	Johns Hopkins Hospital to North Avenue	Extension of Metro
MARC Growth and Investment (2016-2025 and 2016-2035)	West Baltimore, Odenton, Martin State and others	Improvements to capacity, maintenance facilities and station areas
MTA Bus	Statewide	Fleet Improvement
MTA Bus and Rail Improvements	Statewide	Preservation and improvements to bus, Central Light Rail, Metro facilities, MTA offices, and park-and-ride lots
MTA Transit	Statewide	Preservation and improvements to Central Light Rail fleet

Table 3: 2035 Planned and Programmed Transportation Improvements

Facility	Location	Description
Regional Highway Projects		
I-95, JFK Hwy (Section 100)	I-895 to north of MD 43	Add two Express Toll Lanes in each direction, upgrade interchanges at I-895, I-695, and MD 43
MD 295	I-695 to I-195	Widen from 4 to 6 lanes
I-695	I-83 to I-95	Widen from 6 to 8 lanes
Local Projects in the Project Study Corridor		
Reconnecting West Baltimore	West Baltimore	Bicycle/pedestrian facilities at Fulton Street Bridge and between Harlem Park and University of Maryland, SWM/landscaping
Edmondson Avenue Bridge	Over Gwynns Falls/CSX Railroad	Bridge widening from 8 to 10 lanes to accommodate dual track light rail
Boston Street Realignment	Between Boston Street and O'Donnell Street	New, extended roadway
Citywide Street and Urban Reconstruction	North Avenue streetscape, West Baltimore MARC neighborhood improvements, etc.	Road resurfacing/reconstruction
Old Ingleside Avenue Bridge	Bridge #96 over Dead Run	Bridge repair/deck replacement
Rolling Road Bridge	Bridge #358 over Branch of Dead Run	Bridge repair/deck replacement
Ingleside Avenue Bridge	Bridge # 97 over Dead Run and Dogwood Road	Bridge repair/deck replacement
Canton Truck Bypass	Clinton Street to Haven Street	New two lane roadway to accommodate truck traffic from Port
Security Boulevard	Existing terminus to Fairbrook Road	New two lane roadway
Bicycle/Pedestrian Projects		
Haven Street Trail (Red Line Rail with Trail)	Highlandtown to Canton Waterfront Park	Multimodal trail
MLK Jr. Boulevard Side Path	Jones Falls Trail at Maryland Avenue to Gwynns Falls Trail sidewalk at ramp to Russell Street	Rehabilitation/widening of existing sidepath
Red Line Trail	Baltimore City to Red Line terminus in County	Off-road trail linking City and County major employment destinations

Sources: Baltimore Region Transportation Improvement Program 2012-2015, Baltimore Regional Transportation Board "Plan It 2035"

4.10 Attainment Status/Regional Air Quality Conformity

The Clean Air Act requires that EPA publish a list of all geographic areas in compliance with the NAAQS, as well as those areas not in attainment of the NAAQS (42 U.S.C. § 7506(c)). The designation of an area is made on a pollutant-by-pollutant basis. The EPA's area designations are shown in **Table 4**. Ozone nonattainment areas can be classified as marginal, serious, severe, or extreme based on the degree of nonattainment, and different levels of controls and attainment deadlines apply to each area.

Table 4: Attainment Classifications and Definitions

Attainment	Unclassified	Maintenance	Nonattainment
Area is in compliance with the NAAQS.	Area has insufficient data to make a determination and is treated as being in attainment.	Area once classified as nonattainment but has since demonstrated attainment of the NAAQS.	Area is not in compliance with the NAAQS.

Source: Red Line Air Quality Technical Report, 2012

The project study corridor encompasses both Baltimore City and Baltimore County. Baltimore City is classified as a maintenance area for CO, whereas Baltimore County is classified as attainment for CO. Both areas are classified as nonattainment areas for $PM_{2.5}$ and as serious nonattainment areas for O_3.

Baltimore City and Baltimore County are part of the Baltimore Regional Transportation Board (BRTB). The BRTB is the federally-designated Metropolitan Planning Organization (MPO) for the Baltimore region. The BRTB represents the cities of Annapolis and Baltimore and the counties of Anne Arundel, Baltimore, Carroll, Harford and Howard. The mission of the BRTB is to provide regional transportation planning and policy making for the Baltimore region. As the MPO, the BRTB is directly responsible for making sure that any money spent on existing and future transportation projects and programs is based on a continuing, cooperative and comprehensive planning process. All transportation projects in the Baltimore region that receive federal funding, such as the Red Line project, go through this planning process.

The BRTB provides policy direction and oversight in the development of a federally-mandated Transportation Improvement Program (TIP), the Long Range Transportation Plan (LRTP) and the transportation element of the State Air Quality Implementation Plan (SIP).

The TIP is financially constrained over 5 years covering the most immediate implementation priorities for surface transportation projects and strategies from the LRTP. The TIP includes all state and local projects that request federal dollars to implement (those projects have a state or local dollar match). The 2012-2015 TIP was adopted by the Baltimore Regional Transportation Board on November 14, 2011.

The LRTP is a long range transportation plan guiding transportation system improvements for the Baltimore metropolitan region. It serves as a blueprint for long and short range strategies and actions for developing an integrated intermodal transportation system to facilitate the efficient movement of people and goods. The area's LRTP –*Plan It 2035* was approved by the BRTB on November 14, 2011.

The MDE has prepared an attainment plan for the annual $PM_{2.5}$ standard, which was approved for the Baltimore region in February 2006. The LRTP – "*Plan It 2035*" was found to conform, by the BRTB on November 14, 2011, with the Clean Air Act Amendments of 1990.

An in depth Air Quality Analysis was completed for the Red Line and report were prepared in July 2008 as supporting documentation for the Alternatives Analysis/Draft Environmental Impact Statement. The analysis was updated in 2012 using the Preferred Alternative for the FEIS. Refer to the *Air Quality Technical Report* for the complete air quality analysis on the Preferred Alternative.

Pollutants that can be traced principally to motor vehicles are relevant to the evaluation of the project's impacts. These pollutants include carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_x), ozone (O_3), particulate matter- smaller than or equal to 10 microns (PM_{10}), particulate matter- smaller than or equal to 2.5 microns ($PM_{2.5}$), and mobile source air toxics (MSAT).

The purpose and need of the project focuses on meeting the current and future regional transportation needs of the area. The project is intended to contribute to achieving the region's air quality goals as part of an integrated, multi-modal regional transportation plan. The project is not predicted to cause or exacerbate a violation of the NAAQS. The project is not expected to measurably increase regional emission burdens or MSAT levels. The project is also not expected to cause a violation of the $PM_{2.5}$ standard.

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
MARYLAND TRANSIT ADMINISTRATION

Baltimore, Maryland

Baltimore Red Line

TRAVEL FORECASTS RESULTS REPORT

November 2012

Document No. 1748

TABLE OF CONTENTS

Page

List of Tables

Page

List of Figures

Page

1 INTRODUCTION

The Red Line Corridor is a proposed 14-mile light rail line (LRT), running in an east-west direction. The line would connect the areas of Woodlawn, Edmondson Village, West Baltimore, Downtown Baltimore, Inner Harbor East, Fells Point, Canton, and the Johns Hopkins Bayview Medical Center Campus. The majority of the corridor falls within Baltimore City with the westerly four miles located in Baltimore County. The trains will operate at 7 minutes headway during peak period and 10 minutes during off-peak period. The Red Line would run on a dedicated at-grade median transitway for the most part, with two tunnel sections (Cooks Lane and downtown) providing access at 19 stations, with Park-and-Ride facilities at five of the stations. The proposed stations are as follows:

1. Centers for Medicare and Medicaid Services Station
2. Security Square Station
3. Social Security Administration Station
4. I-70 Park-and-Ride Station
5. Edmondson Village Station
6. Allendale Station
7. Rosemont Station
8. West Baltimore MARC Station
9. Harlem Park Station
10. Poppleton Station
11. Howard Street/University Center Station
12. Inner Harbor Station
13. Harbor East Station
14. Fells Point Station
15. Canton Station
16. Brewers Hill/Canton Crossing Station
17. Highlandtown/Greektown Station
18. Bayview Campus Station
19. Bayview MARC Station

1.1 Purpose of the Report

The purpose of this report is to provide the supporting transit ridership information referenced in the Case for the Project. Additional information is provided to shed insights into the impacts of the project based on the existing and projected development in the region and areas served by the proposed Red Line. This report also uses information presented in other supporting documents listed below:

- Baltimore Red Line Case for the Project, January 2010
- Baltimore Red Line Corridor Transit Study Travel Model: Calibration and Validation Report, June 7, 2010
- Transportation Outlook 2035, Baltimore Metropolitan Council
- Underlying Support to Baltimore Metropolitan Council's Round 7 Population and Employment Forecasts, Technical Memorandum, January 2, 2011

- Baltimore Red Line Final Environmental Impact Statement, planned for December 2012
- Baltimore Red Line Bus Operations Plan, May 2012
- Baltimore Red Line Traffic and Parking Technical Report (September 2012)

1.2 Case for the Project

The Case for the Project presentation and written summary evolved through an iterative and coordinated process involving the Federal Transit Administration (FTA) and the Maryland Transit Administration (MTA). The Case for the Project describes the setting today and in the future and summarizes the merits of the project based on benefits for each of the key travel markets. Information used in the Case for the Project was obtained from analysis of the travel forecasts. This report documents and provides the technical background supporting the assertions presented in the Case for the Project. The Red Line LRT is being planned as a solution to the mobility problems in the corridor:

- Presence of major regional employment locations within the corridor – Social Security Administration (SSA) on the west end, the Central Business District (CBD) in the middle, and Johns Hopkins Bayview Medical Campus on the east end.
- Large transit dependent population in the corridor with the proportion of zero-car households exceeding as much as 70 percent.
- Limited opportunity for highway improvement – highly congested roadways and corridor not served by high level roadways at either end; east end served only by 2-lane roads.
- High number of transit riders on slow buses – corridor served by several high ridership routes, with nearly 48,000 daily riders; slow transit travel times due to highway congestion.
- Transportation System Management (TSM) strategies limited by existing conditions – the only low-cost option available was to add new bus service at higher level frequencies.
- Significant travel time improvements with the proposed guideway – a trip from the Bayview Medical Complex to the Social Security Administration would take only 48 minutes compared to nearly 85 minutes by bus, a savings of 37 minutes.
- Significant benefits and large increase in new riders with the proposed guideway – the Red Line would attract 18,800 new riders and nearly 17,700 hours of user benefits (compared with the Low-Cost Alternative).
- Project would have a dramatic impact even if built today – if the Red Line existed in 2005, it would attract 32,200 riders, or approximately 60 percent of the 54,500 riders forecasted for 2035.

1.3 Project Context

The Red Line Corridor extends 14 miles in an east-west direction through Baltimore City with the westerly four miles located in Baltimore County. The line serves major regional facilities such as the Social Security Administration to the west, Downtown Baltimore, and the Johns Hopkins Bayview Medical Center Campus to the east. Additional areas served by the line include the areas of Woodlawn, Edmondson Village, West Baltimore, Inner Harbor East, Fells Point, and Canton, as shown in Figure 1.

The following is a brief overview of the character of the areas served by the Red Line:

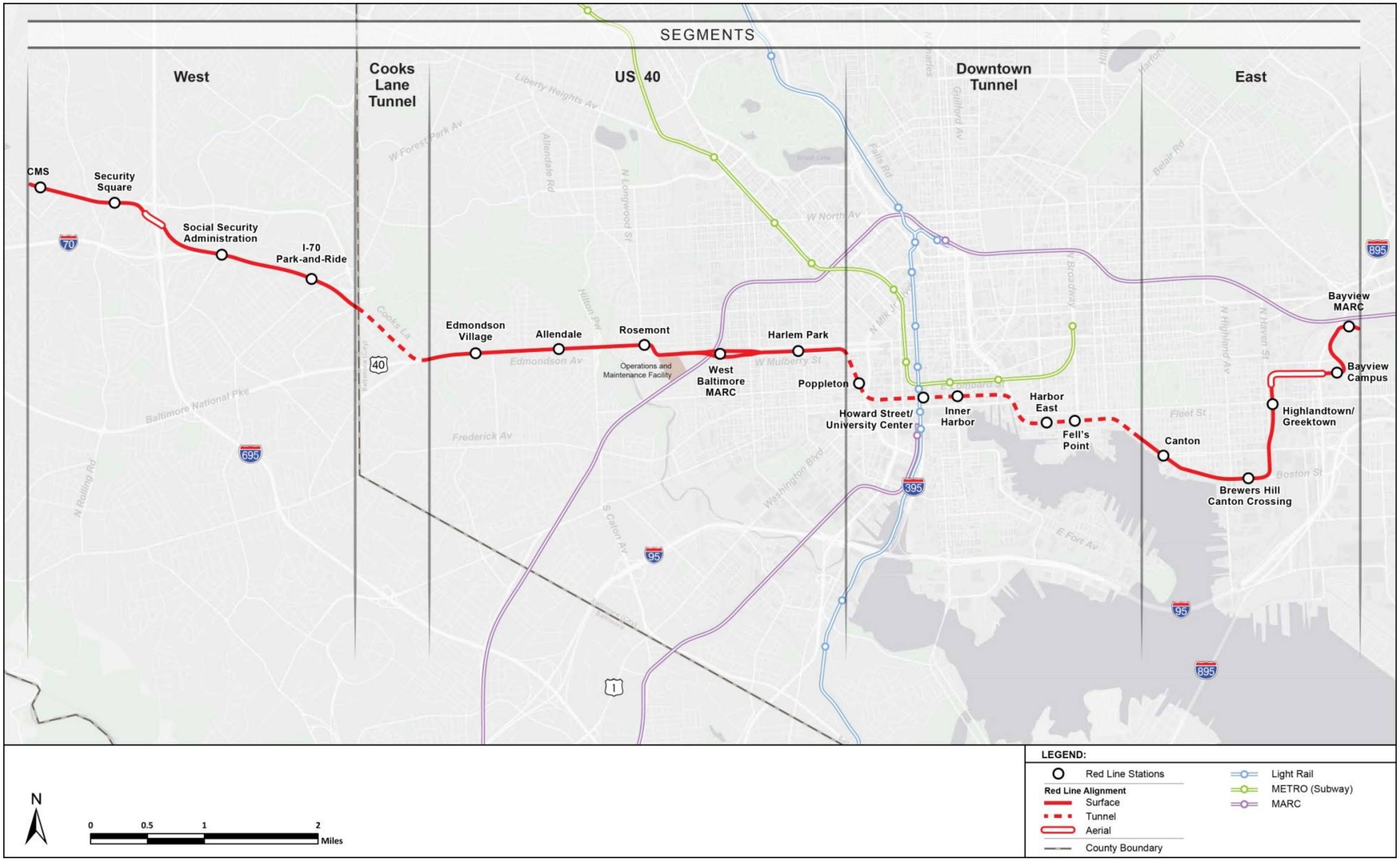
- The four-mile portion at the western end of the corridor in Baltimore County contains major employment centers, shopping, interstate highways, and some moderate-density housing. One of the region’s largest employment centers, the Social Security Administration, is located in the Woodlawn area.

- Traveling east toward the city line, residential densities increase where the pattern of development resembles a grid. Leakin Park and Gwynns Falls Park, large city-owned parks, lie just within the city limits, north of the corridor. Moving toward the downtown area, the corridor intersects with the West Baltimore MARC Station, schools, and shopping centers, all within residential neighborhoods.

- The downtown Central Business District (CBD) has commercial and institutional land uses, with densely developed residential areas radiating out toward the city/county boundary. The CBD is a major employment center for government, healthcare, and businesses. It includes not only the Inner Harbor, a nationally known tourist destination, but it is also home to major league baseball, football, indoor soccer teams, universities and professional schools, hospitals, governmental agencies, and many financial institutions. The CBD has recently been the site of new residential development. It offers a number of opportunities to connect with MARC, Metro, Light Rail, and the MTA core bus system.

- In the eastern portion of the corridor, the Fells Point and Canton areas are undergoing intense infill development, creating even greater residential density and numerous business opportunities. The easternmost end of the corridor comprises mostly industrial and institutional uses, including the Johns Hopkins Bayview Medical Center.

Figure 1 - Red Line Corridor Project Study Area



The Red Line Corridor is currently served by 23 bus routes providing bus service within the corridor. These routes, illustrated in Figure 2, either cross or operate parallel to the proposed Red Line, excluding those in the Central Business District (CBD). Local bus is the primary transit mode within the corridor, with a few routes providing peak-hour only service. Four (13, 15, 20, and 23) of the top 10 bus routes (based on daily riders) in the Baltimore region operate within the Red Line Corridor. Bus routes in the corridor carry close to 43 percent (97,600) of the total daily bus ridership in MTA's system (MTA Spring 2012 ridership data), excluding MARC and urban rail riders. The primary bus service is described below:

- Route 13 serves the Canton area to the Bayview Medical Campus, carrying 10,580 riders per day.

- The Social Security Administration and Security Square Mall located in the western end of the corridor are served by Route 15, which runs to Downtown Baltimore (with some service continuing on to Perry Hall and White Marsh). Route 15 is one of the highest ridership bus routes with an average of over 12,300 riders every weekday.

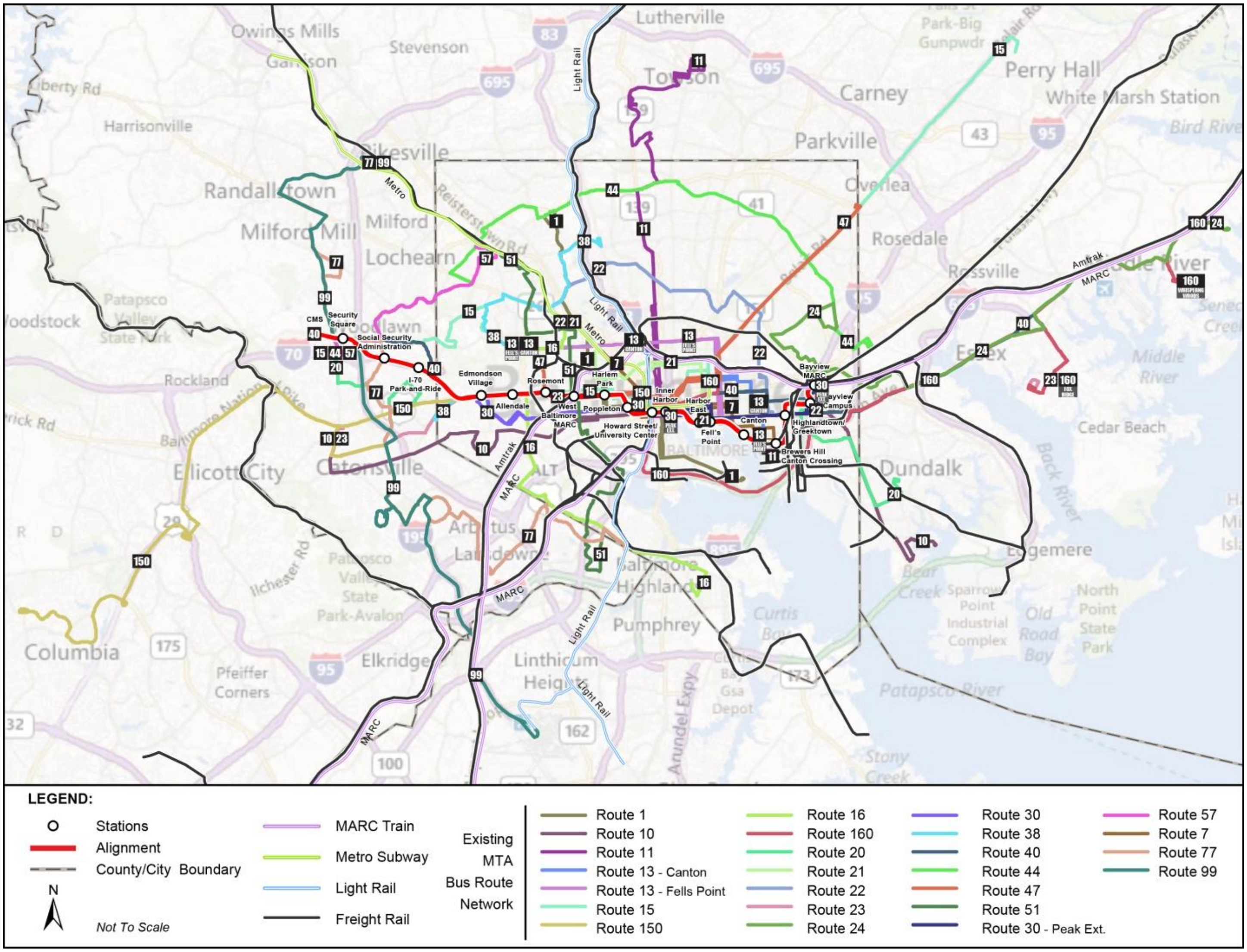
- Security Square Mall, Edmondson Village, and Dundalk (eastern end of the corridor) along Baltimore and Fayette Streets are served by Route 20, a few blocks south of Routes 23 and 15. Route 20 averages 9,000 riders each day.

- Route 23 serves the Edmondson Village area to the Bayview Medical Campus and has an average weekday ridership of over 10,900.

- Security Square Mall, Downtown Baltimore, and Bayview Medical Campus are served by MTA's QuickBus 40 providing limited stop service. The route extends to the Essex Park-and-Ride lot and further east along Eastern Avenue with average daily trips of over 8,250.

Metro, Central Light Rail, and MARC train service serves the project study area with north-south routes, but generally train service does not serve east-west trips along the corridor. The one exception is the Metro line that a limited portion serves some east-west trips through downtown in its subway portion.

Figure 2 - Red Line Corridor Existing Transit Service



2 EXISTING AND FUTURE CONDITIONS

This section provides an overview of the Red Line Corridor in context with the entire region. This section also provides a look at how population and employment will grow and how transit travel times and highway congestion will continue to increase and worsen over the next decades. The corridor also has a high percentage of its population relying on transit for their daily transportation needs.

2.1 Demographic Growth

Between 2005 and 2035, as seen in Table 1, households in the region are expected to increase by 3 percent and employment by 24 percent.

More than half of the region's population growth is expected to occur in the Red Line Corridor for an increase of approximately 45,000 residents. The number of households in the corridor shows a 16 percent increase compared to 3 percent in the region. By 2035, the number of households will increase by close to 27,000 in the corridor compared to a 35,500 increase in employment. The Baltimore CBD shows the largest increase in households over the 30-year analysis period.

While the Baltimore CBD will experience the largest increase in population over the 30-year analysis period and a more modest 6 percent growth in employment, other areas will show increases in employment as high as 45 percent. Overall, employment in the Red Line Corridor will grow at slightly less than half the rate of the region, 11 percent compared to 24 percent. Approximately 9 percent (35,500) of the region's growth will occur in the Red Line Corridor between 2005 and 2035.

Table 1 – Demographic Growth (2005 to 2035)

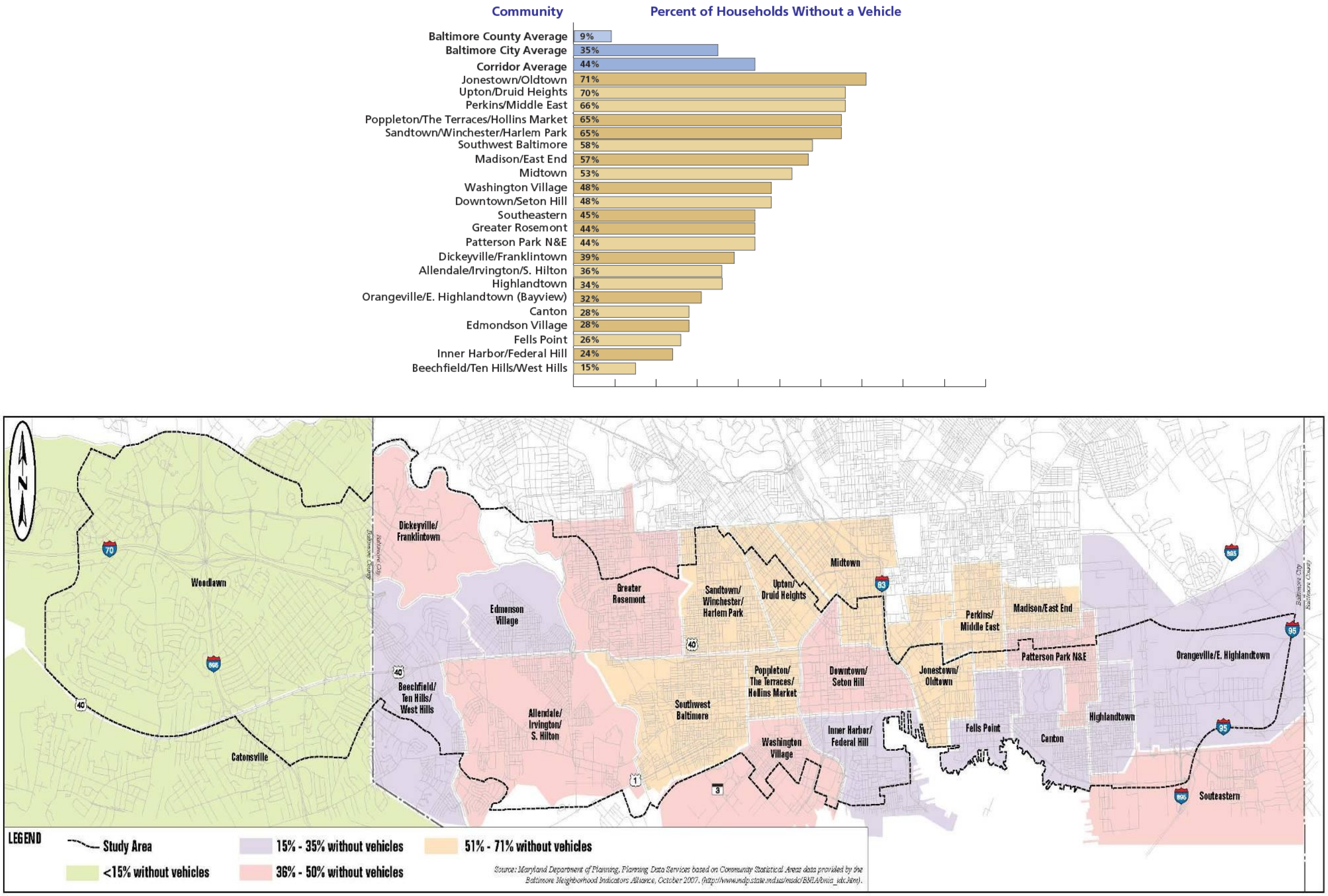
	Population			
	Year 2005	**Year 2035**	**Increase**	**Percent Change**
Edmondson Village	32,791	33,415	624	2%
Rosemont	29,623	31,119	1,496	5%
Poppleton	58,213	70,159	11,946	21%
Baltimore CBD	18,508	37,184	18,676	101%
East Baltimore CBD	47,475	51,730	4,255	9%
Canton	42,894	45,338	2,444	6%
East Baltimore City	15,647	18,895	3,248	21%
SSA/Security Square	39,860	43,026	3,166	8%
Total Corridor	**285,011**	**330,866**	**45,855**	**16%**
Total Region	**2,634,241**	**2,708,475**	**74,234**	**3%**
Percent Region Growth Occurring in the Corridor			**62%**	

Table 1 – Demographic Growth (2005 to 2035)
(Continued)

	Households			
	Year 2005	**Year 2035**	**Increase**	**Percent Change**
Edmondson Village	12,397	13,388	991	8%
Rosemont	10,582	11,448	866	8%
Poppleton	23,548	29,764	6,216	26%
Baltimore CBD	10,641	22,605	11,964	112%
East Baltimore CBD	15,067	16,818	1,751	12%
Canton	18,027	20,156	2,129	12%
East Baltimore City	6,318	7,883	1,565	25%
SSA/Security Square	15,554	17,100	1,546	10%
Total Corridor	**285,011**	**330,866**	**27,028**	**16%**
Total Region	**2,634,241**	**2,708,475**	**74,234**	**3%**
Percent Region Growth Occurring in the Corridor			**36%**	
	Employment			
	Year 2005	**Year 2035**	**Increase**	**Percent Change**
Edmondson Village	4,932	5,177	245	5%
Rosemont	5,643	8,184	2,541	45%
Poppleton	22,557	23,372	815	4%
Baltimore CBD	136,461	144,808	8,347	6%
East Baltimore CBD	54,932	63,831	8,899	16%
Canton	12,201	16,128	3,927	32%
East Baltimore City	31,093	38,219	7,126	23%
SSA/Security Square	47,549	51,136	3,587	7%
Total Corridor	**315,368**	**350,855**	**35,487**	**11%**
Total Region	**1,615,172**	**2,006,083**	**390,911**	**24%**
Percent Region Growth Occurring in the Corridor			**9%**	

The Red Line Corridor also serves a large transit dependent population. As seen in Figure 3, the percentage of households without a vehicle ranges from 15 to 71 percent. On average, the percentage of households without a vehicle in the Red Line Corridor is 44 percent, well above the Baltimore County average of 9 percent and the Baltimore City average of 35 percent.

Figure 3 – Percent of Households without a Vehicle



2.2 Roadway Levels of Congestion

The Red Line Corridor currently faces persistent traffic congestion, affecting both automobiles and buses. The main roadway link in the corridor, US 40, is a heavily traveled arterial with high-density residential and commercial activities. The numerous and closely spaced traffic signals along the roadway combined with the projected demographic growth contribute to modestly reducing travel speeds from approximately 28 mph to 27 mph from the CBD to SSA and from 24 mph to 22 mph from Bayview Medical Center to the CBD between base and future years based on information within the Baltimore Metropolitan Council (BMC) travel demand model.

The traffic operational analysis documented in the *Red Line Traffic and Parking Technical Report* (September 2012) shows increases in travel time through the CBD. Increases in travel times will range from relatively minor changes (e.g., AM peak hour along Security Boulevard between Greengage Road and Woodlawn Drive) to more significant changes such as along Lombard Street between President Street and MLK Jr. Boulevard and along Edmondson Avenue between Cooks Lane and Franklin Street. Details of the travel times along the corridor can be found in the *Red Line Traffic and Parking Technical Report*.

The reduction in travel times along the corridor reflect highway improvements planned within the corridor by 2035 as seen in Table 2. Committed transportation projects identified in the BMC Constrained Long Range Transportation Plan (CLRP) include the following:

- Security Boulevard Extension, existing terminus to Fairbrook Road
- West Baltimore MARC Station Improvements
- Uplands Development
- Boh'Donnell Connector
- Bayview MARC and Intermodal Station
- US 40 Edmondson Avenue Bridge expansion over Gwynns Falls/CSX Railroad

A brief description of the projects listed above is provided in the *Red Line Traffic and Parking Technical Report*.

Table 2 – Peak Hour Highway Speeds and Travel Times on Major Arterials

Street	**From**	**To**	**Distance** (mile)	**Measure**	**2005**	**2035 No-Build Alternative**
US 40	Bayview Medical Center Campus	Baltimore CBD	3.98	Travel Time (min)	10	11
				Speed (mph)	24	22
	Baltimore CBD	Social Security Administration	7.80	Travel Time (min)	17	17
				Speed (mph)	28	27

2.3 Transit Travel Times

Buses in the corridor are subject to the same traffic conditions as automobiles but have longer travel times due to frequent stops. Bus speeds in the Red Line Corridor range from 9 mph to 13 mph as all the current service is provided in mixed traffic flow. The operational speeds of most local bus routes during the peak period average only 9 mph between Bayview Medical Center Campus and Downtown Baltimore, for a total travel time of 28 minutes. Nonstop express bus services make the trip in 22 minutes, saving only 4 minutes.

These speeds are expected to decrease even further by 2035 as seen in Table 3, as no major transit service is planned in the future. Future transit improvements impacting the corridor include an increase in bus fleet size to accommodate growth, allowing service frequencies to remain the same as today to accommodate longer bus travel times due to increased congestion.

Table 3 – Peak Hour Bus Speeds on Major Routes

Bus Route	**From**	**To**	**Distance** (mile)	**Measure**	**2005**	**2035 No-Build Alternative**
Route 15	Social Security Administration	Downtown Baltimore	7.8	Travel Time (min)	64	69
				Speed (mph)	7	7
Route 20	Security Square Mall	Edmondson Village	4.42	Travel Time (min)	23	26
				Speed (mph)	11	10
Route 23	Edmondson Village	Bayview Medical Center Campus	7.97	Travel Time (min)	75	80
				Speed (mph)	6	6
MTA QuickBus Route 40	Downtown Baltimore	Bayview Medical Center Campus	4.21	Travel Time (min)	26	28
				Speed (mph)	10	9

2.4 Travel Market and Person Trip Growth

Generated based on the regionally adopted population and employment data, forecasted person trips are a key element predicted in the travel forecasting model. Aggregated by districts, person trips are based on Traffic Analysis Zones (TAZs) and provide a wealth of information regarding the magnitude of trips produced and attracted to specific areas.

For ease of analysis, the TAZs in the Red Line Corridor and the region were grouped into districts as shown in Figure 4. Districts 5 through 10, 12, and 14 represent the districts directly impacted by the Red Line project. The remaining districts represent the various areas outside of the primary zone of influence of the project.

The four major markets identified for this project are as follows:

- Attractions to the CBD, including commuters from outside the corridor
- Attractions to the Social Security Administration (SSA)
- Attractions to the Bayview Medical Center
- Residents who live and travel in the corridor, not going to the above markets

The 2005 and 2035 total daily person trip summaries provided in Table 4 and Table 5 were used to identify the size of each of the four major travel markets in the corridor and the overall growth in person trips. Table 6 displays the differences between 2005 and 2035.

Daily person trips in the region will increase by 1,281,000 trips, or a 17 percent growth between 2005 and 2035. The markets served by the corridor are expected to increase by approximately 72,600 trips per day between 2005 (691,700) and 2035 (764,300). In 2035, of the total Red Line Corridor market share of 764,300 daily person trips, approximately 266,300 (35 percent) trips are attracted to the Baltimore CBD, 121,300 (16 percent) to the Social Security Administration area, 67,900 (9 percent) to the Bayview Medical Center, and the remaining 308,800 (40 percent) trips are from residents who live and travel in the corridor. Attractions to the Bayview Medical Center show the largest increase in the number of daily person trips or 24 percent between 2005 and 2035.

2.5 Travel Market and Transit Trip Growth

Overall travel by transit in the Baltimore region is predicted to increase from just over 200,000 riders per day in 2005 to approximately 237,000 riders per day in 2035 (see chapter 5 for more details on the nature and distribution of this increase). This estimate includes both local and express bus riders, Urban Rail riders (Light Rail and Metro), and Commuter Rail riders (MARC).

This projected increase of 37,000 daily riders represents an increase of slightly more than 18 percent and parallels the growth in land use and demographics and the corresponding person trip growth.

As part of the analysis of the changes in transit travel between 2005 and 2035, a stepwise build-up of the 2035 forecast was performed. This analysis provides insight into the key contributors to any change in ridership between the base and future year. The analysis revealed that 11,000 of the 37,000 increase stems from regional improvements in service frequencies and coverage over the 30-year period. Another 19,000 riders are added as a function of the growth in person travel, and only 7,000 new riders are in response to changing conditions and congestion on regional highways and arterial roads.

Figure 4 – Red Line Corridor District Map

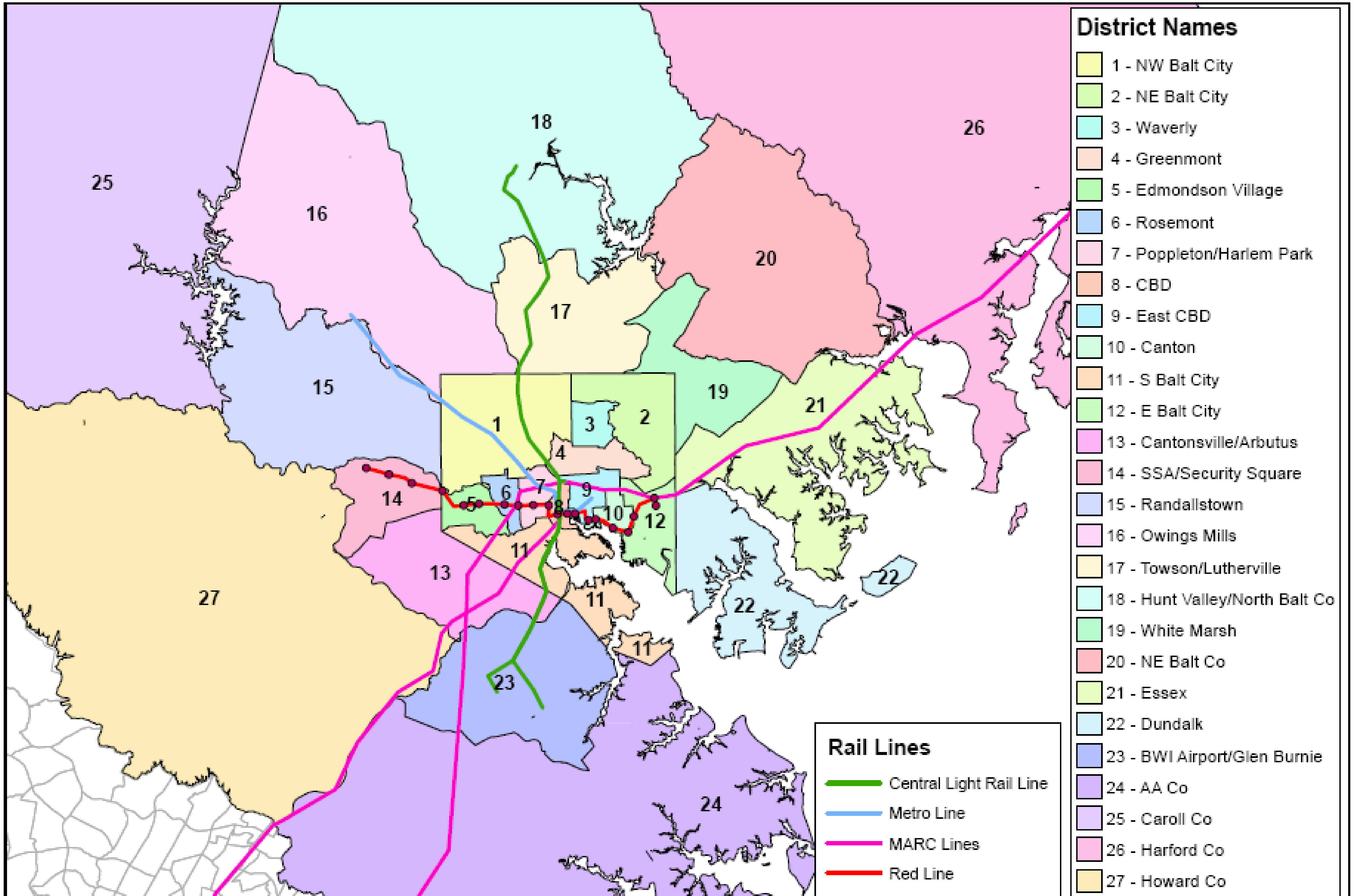


Table 4 – Red Line Corridor Daily Person Trips – 2005

Productions	District	Attractions																												Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
1	NW Balt City	127,519	10,996	6,646	12,540	6,280	7,712	13,554	20,083	10,975	3,186	8,204	2,012	6,893	12,594	22,241	25,962	25,600	11,270	3,176	1,628	2,596	2,217	4,013	4,202	2,613	1,560	9,146	6,842	372,260
2	NE Balt City	14,956	51,704	9,799	12,489	542	732	3,397	10,991	8,322	3,402	3,663	4,866	1,799	1,677	1,739	4,023	26,737	4,866	26,579	9,908	11,591	7,893	2,468	2,811	423	2,005	3,273	3,180	235,835
3	Waverly	10,622	11,609	7,364	6,959	241	532	1,792	4,735	3,563	902	1,284	920	707	571	810	1,495	8,753	1,738	3,111	1,250	1,260	1,362	617	536	152	262	1,075	1,402	75,624
4	Greenmont	11,829	13,076	5,623	16,445	525	971	4,090	9,534	9,638	3,385	2,738	2,309	1,340	869	952	1,697	5,656	2,118	3,609	1,552	3,287	3,970	1,312	1,109	139	497	1,878	1,614	111,762
5	Edmond. Vill.	6,307	497	309	1,154	9,438	4,386	3,061	4,538	1,773	595	7,901	420	8,851	6,039	2,424	1,247	813	569	308	133	336	504	2,891	2,769	436	168	5,073	2,479	75,419
6	Rosemont	8,512	721	331	1,343	4,712	6,576	6,258	5,282	2,151	913	5,637	428	3,431	1,907	1,176	733	839	425	199	94	276	465	1,705	1,498	233	288	1,863	1,267	59,263
7	Poppleton	12,762	2,009	895	4,330	2,848	5,792	14,264	14,742	5,400	2,330	8,902	1,052	3,442	1,520	1,243	1,432	2,369	1,246	509	253	700	1,204	2,528	2,178	223	782	2,309	3,554	100,818
8	CBD	4,372	1,489	523	2,360	819	1,090	3,826	8,589	4,539	2,378	5,306	961	2,207	910	753	934	1,710	1,039	779	372	1,035	1,463	2,684	2,436	64	441	3,013	4,954	61,046
9	East CBD	4,981	4,962	1,544	6,566	493	880	3,383	10,704	11,591	6,319	3,086	2,770	1,196	585	515	871	2,187	1,143	1,650	730	2,420	3,409	1,030	891	49	268	2,109	1,187	77,519
10	Canton	3,327	3,388	912	3,716	470	655	2,338	9,618	9,265	13,300	3,440	7,192	1,398	496	472	1,103	1,574	1,002	1,783	977	3,373	7,193	2,175	2,274	74	814	3,385	2,850	88,564
11	S Balt City	5,676	1,487	555	2,409	5,971	3,320	6,030	12,811	4,554	2,613	35,455	2,187	15,528	3,091	1,776	1,466	1,508	901	872	419	1,229	3,461	18,941	10,742	429	1,627	7,767	7,088	159,913
12	E Balt City	837	2,298	343	1,216	143	147	447	1,985	1,919	3,425	1,468	6,899	648	254	195	438	938	463	1,573	773	2,877	10,124	1,269	1,255	29	398	1,205	446	44,012
13	Cantonsville	5,588	697	272	1,040	6,540	2,422	2,896	7,002	2,103	976	16,781	890	47,640	18,402	6,258	3,607	2,286	1,833	702	456	1,025	1,358	18,554	17,177	963	645	27,562	8,461	204,136
14	SSA/Sec. Sqr.	7,250	463	244	857	3,540	1,179	1,334	3,705	1,586	339	3,729	456	15,438	33,615	13,540	4,464	2,127	1,539	380	346	589	535	3,936	3,917	1,183	391	22,294	3,530	132,506
15	Randallstown	26,498	1,673	945	2,259	2,872	1,572	2,818	8,769	3,897	651	3,993	954	9,179	25,426	123,009	38,231	7,493	6,370	1,270	1,475	2,802	1,004	4,705	4,904	8,990	513	21,824	5,770	319,866
16	Owings Mills	22,961	2,611	667	2,321	938	624	1,858	7,349	3,108	992	2,667	2,343	4,273	6,515	33,210	127,311	17,388	15,527	5,170	2,686	5,074	2,110	2,887	2,988	13,140	3,049	10,008	3,034	302,809
17	Towson/Luther.	18,260	15,338	3,785	3,945	402	486	1,895	8,775	3,819	1,013	2,310	1,457	1,924	2,904	5,763	15,607	131,547	34,188	20,189	8,742	6,544	2,495	1,689	1,348	858	2,448	5,229	1,788	304,748
18	Hunt Val./N Balt	7,337	2,560	553	1,590	301	326	1,254	5,639	2,187	701	1,679	1,619	1,811	2,410	4,753	17,212	35,738	99,911	5,866	5,756	4,557	1,919	1,797	2,000	8,271	6,276	4,706	2,004	230,733
19	White Marsh	4,301	19,392	1,617	3,125	237	277	1,161	4,543	2,794	1,430	2,405	2,855	1,354	1,166	1,741	5,230	28,321	6,905	51,475	24,265	22,247	6,465	2,104	2,110	384	5,761	2,467	1,275	207,407
20	NE Balt Co	3,673	8,146	769	1,849	195	190	827	4,337	1,938	1,027	1,720	1,829	1,279	1,515	2,123	7,211	18,830	10,813	29,876	63,971	11,245	3,700	2,076	2,294	1,184	19,376	2,911	1,617	206,521
21	Essex	4,208	9,170	802	3,130	339	316	1,310	5,984	3,501	2,666	2,961	4,195	1,851	1,738	2,137	8,572	12,072	8,435	24,261	11,731	107,302	15,697	3,274	3,972	1,159	7,475	3,740	1,860	253,858
22	Dundalk	2,454	5,819	872	3,184	424	387	1,115	5,721	4,222	5,318	4,978	16,878	2,445	1,087	1,039	2,618	3,895	2,714	6,552	3,012	14,959	82,993	6,621	10,929	287	2,145	4,860	2,140	199,668
23	BWI/Glen Burnie	1,973	747	156	774	984	645	1,391	6,030	1,447	869	13,395	1,106	10,892	2,951	1,943	1,483	1,180	941	746	588	1,117	2,470	92,538	67,871	489	927	8,970	7,232	231,855
24	AA Co	4,046	1,164	300	1,553	1,230	787	2,263	13,553	3,197	1,381	12,394	1,994	12,104	4,790	3,962	3,111	2,739	2,822	1,684	1,379	2,366	5,663	90,961	930,537	1,131	1,912	46,058	104,209	1,259,290
25	Caroll Co	3,018	412	112	894	298	127	620	3,549	941	230	2,175	356	2,079	3,704	15,263	21,828	4,133	10,523	778	1,685	2,571	417	2,360	4,200	333,042	539	22,379	23,243	461,476
26	Harford Co	3,431	3,977	566	1,931	304	241	1,098	6,607	3,023	1,151	3,289	3,512	1,560	1,567	1,338	7,116	9,500	10,888	7,980	12,236	6,508	3,803	2,325	1,975	561	557,028	3,053	2,609	659,177
27	Howard Co	7,768	1,248	558	2,055	2,935	1,566	2,589	13,950	4,140	1,246	8,153	1,371	19,275	20,046	10,081	5,343	3,974	3,199	1,097	852	1,496	1,787	15,410	51,829	9,947	686	530,508	104,325	827,434
28	External	5,032	815	1,016	2,100	693	541	2,037	9,225	3,188	766	5,176	973	6,337	3,750	3,701	2,747	2,594	2,652	648	883	1,350	1,337	11,471	102,155	16,203	1,369	107,215	0	295,974
	Total	**339,498**	**178,468**	**48,078**	**104,134**	**54,714**	**44,479**	**88,906**	**228,350**	**118,781**	**63,504**	**174,889**	**74,804**	**186,881**	**162,099**	**264,157**	**313,092**	**362,501**	**246,040**	**202,822**	**158,152**	**222,732**	**177,018**	**304,341**	**1,242,907**	**402,656**	**619,650**	**865,880**	**309,960**	**7,559,493**

Markets	Summary	Percent of Total	Notes
Attractions to the CBD	249,744	36%	All Region to Districts 8 and 9
Attractions to SSA	116,773	17%	All Region to Distrcit 14
Attractions to the Bay View Medical Center	54,626	8%	All Region to District 12
Residents who live and travel in the corridor	270,569	39%	Within Corridor
Total Markets	691,712	9%	
Total Region	7,559,493		

Table 5 – Red Line Corridor Daily Person Trips – 2035

Productions	District	Attractions																												Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
1	NW Balt City	126,932	11,253	6,165	12,973	6,096	7,458	15,489	25,967	12,592	3,735	9,780	2,747	7,743	13,665	22,619	29,341	25,153	12,053	3,126	1,666	2,768	2,261	5,963	6,551	2,856	2,316	13,861	6,617	**399,746**
2	NE Balt City	14,972	52,319	9,401	12,254	590	812	3,812	12,368	8,987	3,712	3,899	6,807	1,808	1,870	1,641	4,480	25,717	4,723	27,842	10,515	11,830	8,142	2,497	3,560	496	3,095	4,331	2,349	**244,829**
3	Waverly	10,201	11,972	7,168	6,937	266	681	2,166	6,173	3,957	939	1,635	1,229	857	669	827	1,817	8,809	1,905	3,532	1,401	1,273	1,337	1,064	982	197	455	1,757	1,141	**81,347**
4	Greenmont	11,462	12,808	4,948	15,442	515	933	4,185	10,997	9,613	3,241	3,007	2,500	1,469	934	943	2,004	5,450	2,389	3,856	1,678	3,015	3,531	1,534	1,302	153	849	2,404	1,188	**112,350**
5	Edmond. Vill.	5,984	550	317	1,158	8,524	3,600	2,996	5,137	1,850	648	7,976	521	8,774	5,768	2,152	1,346	789	520	172	129	310	402	3,710	3,689	461	211	6,662	2,524	**76,880**
6	Rosemont	8,647	792	326	1,291	4,170	5,480	6,011	6,082	2,237	940	5,388	504	3,597	2,014	1,139	807	800	391	196	97	260	415	2,399	2,060	253	451	2,646	1,451	**60,844**
7	Poppleton	14,249	2,316	950	4,606	3,159	5,713	16,772	19,006	6,313	2,609	10,823	1,354	4,454	1,891	1,385	1,797	2,548	1,371	554	292	752	1,195	4,479	3,563	265	1,451	4,021	2,523	**120,411**
8	CBD	6,248	2,177	685	3,256	1,132	1,473	6,780	14,481	6,850	3,359	7,751	1,247	3,439	1,309	967	1,366	2,314	1,439	996	489	1,273	1,729	5,250	4,488	71	745	5,478	4,503	**91,295**
9	East CBD	5,153	5,466	1,428	6,298	506	883	3,792	13,524	12,750	6,717	3,929	3,016	1,561	743	555	1,095	2,346	1,363	1,860	851	2,451	3,318	1,569	1,347	48	438	2,683	1,102	**86,792**
10	Canton	3,423	4,006	876	3,752	469	604	2,582	11,732	10,046	13,924	3,675	8,304	1,468	531	459	1,214	1,522	948	1,749	920	3,391	7,270	2,072	2,401	85	1,502	4,262	1,509	**94,696**
11	S Balt City	5,784	1,528	547	2,391	6,160	2,994	6,337	14,995	4,920	2,817	35,169	1,862	15,797	3,380	1,734	1,618	1,493	842	588	263	720	1,583	24,000	14,906	453	1,635	11,504	5,813	**171,833**
12	E Balt City	1,003	3,895	383	1,414	126	171	600	2,821	2,535	4,502	1,213	9,713	509	240	191	544	936	441	1,750	833	3,548	12,082	1,025	1,035	32	805	1,024	359	**53,730**
13	Cantonsville	5,738	765	268	1,024	6,570	2,178	2,930	7,268	2,191	1,092	16,389	907	46,419	19,037	6,004	3,931	2,168	1,605	574	380	771	762	22,543	22,285	1,005	788	35,433	8,208	**219,233**
14	SSA/Sec. Sqr.	7,412	532	253	879	3,407	1,102	1,381	3,673	1,605	394	3,951	535	15,691	35,960	13,950	5,102	2,135	1,441	390	343	530	397	5,045	5,130	1,266	612	25,335	3,600	**142,051**
15	Randallstown	27,959	1,965	1,094	2,587	2,774	1,699	3,140	9,306	4,372	874	4,591	1,339	9,354	27,009	129,097	45,785	7,621	6,226	1,287	1,559	2,883	1,006	6,850	7,372	11,768	821	30,684	6,645	**357,667**
16	Owings Mills	24,670	3,222	705	2,804	1,045	728	2,211	8,142	3,673	1,521	3,444	3,643	4,892	7,251	39,172	149,734	18,845	16,501	5,431	2,989	5,571	2,403	4,724	4,935	18,840	6,214	15,560	3,767	**362,637**
17	Towson/Luther.	18,900	16,407	3,769	4,176	454	545	2,228	10,192	4,443	1,331	2,978	2,072	2,193	3,183	5,584	17,674	138,687	37,348	22,086	9,631	7,065	2,735	2,379	2,211	1,012	3,940	8,547	2,526	**334,296**
18	Hunt Val./N Balt	7,755	2,881	542	1,783	339	390	1,431	5,674	2,373	1,013	2,136	2,325	2,065	2,651	4,678	19,169	37,015	109,006	5,937	6,228	4,791	2,117	3,187	3,689	10,578	9,975	7,811	2,338	**259,877**
19	White Marsh	4,565	21,193	1,588	3,268	250	343	1,326	4,755	3,061	1,684	2,473	3,810	1,318	1,311	1,700	5,947	28,643	6,905	55,657	26,445	23,708	7,178	2,372	2,348	447	9,358	3,522	1,521	**226,696**
20	NE Balt Co	4,278	8,625	736	2,020	218	261	982	4,531	2,264	1,375	1,852	2,561	1,363	1,845	2,168	8,666	18,737	11,028	31,284	69,437	13,995	4,006	2,736	2,992	1,557	29,350	4,830	1,521	**235,218**
21	Essex	4,739	10,956	750	3,131	289	353	1,524	6,533	3,725	2,737	2,384	5,206	1,571	1,991	2,090	10,147	11,890	8,178	25,892	14,419	116,548	16,987	2,957	3,580	1,446	13,773	5,046	1,802	**280,644**
22	Dundalk	2,589	7,872	858	3,211	283	409	1,254	6,193	4,488	5,932	3,965	20,933	1,591	917	906	2,934	3,884	2,531	7,399	3,510	17,832	88,276	5,877	10,342	331	4,166	3,869	1,732	**214,084**
23	BWI/Glen Burnie	2,036	670	164	750	1,024	630	1,500	6,466	1,563	927	13,537	744	10,805	3,120	1,915	1,577	1,039	798	379	283	598	961	107,989	85,625	495	876	13,577	5,519	**265,567**
24	AA Co	3,519	1,028	278	1,348	1,156	747	2,090	11,694	2,699	1,467	11,874	1,636	11,383	4,555	3,517	3,023	2,133	2,200	897	724	1,318	2,234	104,955	1,119,212	1,098	1,863	62,605	108,670	**1,469,923**
25	Caroll Co	3,802	543	139	793	366	151	654	3,376	822	387	2,433	552	2,578	4,681	16,721	27,099	4,550	12,151	832	1,961	2,958	495	4,617	8,752	411,437	1,171	38,105	41,041	**593,167**
26	Harford Co	3,586	5,964	657	2,216	291	294	1,135	5,162	2,750	1,537	2,988	4,304	1,314	1,505	1,129	6,780	8,410	9,701	7,222	12,870	6,791	3,441	2,985	2,599	574	737,659	4,219	1,599	**839,682**
27	Howard Co	8,269	1,329	543	1,960	3,016	1,549	2,425	12,048	3,840	1,358	8,432	1,462	18,334	17,337	10,397	6,595	3,959	3,049	982	793	1,180	1,239	22,675	83,093	12,862	989	676,782	118,509	**1,025,006**
28	External	5,573	903	617	2,098	610	675	1,429	8,651	3,474	969	6,079	1,233	5,626	4,371	3,484	2,896	2,631	2,502	532	765	1,147	1,089	17,904	137,906	31,297	3,694	172,261	0	**420,416**
	Total	**349,448**	**193,937**	**46,155**	**105,820**	**53,805**	**42,856**	**99,162**	**256,947**	**129,993**	**71,741**	**183,751**	**93,066**	**187,973**	**169,738**	**277,124**	**364,488**	**370,224**	**259,555**	**213,002**	**171,471**	**239,277**	**178,591**	**375,357**	**1,547,955**	**511,383**	**839,202**	**1,168,819**	**340,077**	**8,840,917**

Markets	Summary	Percent of Total	Notes
Attractions to the CBD	266,298	35%	All Region to Districts 8 and 9
Attractions to SSA	121,282	16%	All Region to Distrcit 14
Attractions to the Bay View Medical Center	67,872	9%	All Region to District 12
Residents who live and travel in the corridor	308,818	40%	Within Corridor
Total Markets	764,270	9%	
Total Region	8,840,917		

Table 6 – Red Line Corridor Daily Person Trips Growth – 2035 minus 2005

Productions	District	Attractions																												Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
1	NW Balt City	-587	257	-481	433	-184	-254	1,935	5,884	1,617	549	1,576	735	850	1,071	378	3,379	-447	783	-50	38	172	44	1,950	2,349	243	756	4,715	-225	**27,486**
2	NE Balt City	16	615	-398	-235	48	80	415	1,377	665	310	236	1,941	9	193	-98	457	-1,020	-143	1,263	607	239	249	29	749	73	1,090	1,058	-831	**8,994**
3	Waverly	-421	363	-196	-22	25	149	374	1,438	394	37	351	309	150	98	17	322	56	167	421	151	13	-25	447	446	45	193	682	-261	**5,723**
4	Greenmont	-367	-268	-675	-1,003	-10	-38	95	1,463	-25	-144	269	191	129	65	-9	307	-206	271	247	126	-272	-439	222	193	14	352	526	-426	**588**
5	Edmond. Vill.	-323	53	8	4	-914	-786	-65	599	77	53	75	101	-77	-271	-272	99	-24	-49	-136	-4	-26	-102	819	920	25	43	1,589	45	**1,461**
6	Rosemont	135	71	-5	-52	-542	-1,096	-247	800	86	27	-249	76	166	107	-37	74	-39	-34	-3	3	-16	-50	694	562	20	163	783	184	**1,581**
7	Poppleton	1,487	307	55	276	311	-79	2,508	4,264	913	279	1,921	302	1,012	371	142	365	179	125	45	39	52	-9	1,951	1,385	42	669	1,712	-1,031	**19,593**
8	CBD	1,876	688	162	896	313	383	2,954	5,892	2,311	981	2,445	286	1,232	399	214	432	604	400	217	117	238	266	2,566	2,052	7	304	2,465	-451	**30,249**
9	East CBD	172	504	-116	-268	13	3	409	2,820	1,159	398	843	246	365	158	40	224	159	220	210	121	31	-91	539	456	-1	170	574	-85	**9,273**
10	Canton	96	618	-36	36	-1	-51	244	2,114	781	624	235	1,112	70	35	-13	111	-52	-54	-34	-57	18	77	-103	127	11	688	877	-1,341	**6,132**
11	S Balt City	108	41	-8	-18	189	-326	307	2,184	366	204	-286	-325	269	289	-42	152	-15	-59	-284	-156	-509	-1,878	5,059	4,164	24	8	3,737	-1,275	**11,920**
12	E Balt City	166	1,597	40	198	-17	24	153	836	616	1,077	-255	2,814	-139	-14	-4	106	-2	-22	177	60	671	1,958	-244	-220	3	407	-181	-87	**9,718**
13	Cantonsville	150	68	-4	-16	30	-244	34	266	88	116	-392	17	-1,221	635	-254	324	-118	-228	-128	-76	-254	-596	3,989	5,108	42	143	7,871	-253	**15,097**
14	SSA/Sec. Sqr.	162	69	9	22	-133	-77	47	-32	19	55	222	79	253	2,345	410	638	8	-98	10	-3	-59	-138	1,109	1,213	83	221	3,041	70	**9,545**
15	Randallstown	1,461	292	149	328	-98	127	322	537	475	223	598	385	175	1,583	6,088	7,554	128	-144	17	84	81	2	2,145	2,468	2,778	308	8,860	875	**37,801**
16	Owings Mills	1,709	611	38	483	107	104	353	793	565	529	777	1,300	619	736	5,962	22,423	1,457	974	261	303	497	293	1,837	1,947	5,700	3,165	5,552	733	**59,828**
17	Towson/Luther.	640	1,069	-16	231	52	59	333	1,417	624	318	668	615	269	279	-179	2,067	7,140	3,160	1,897	889	521	240	690	863	154	1,492	3,318	738	**29,548**
18	Hunt Val./N Balt	418	321	-11	193	38	64	177	35	186	312	457	706	254	241	-75	1,957	1,277	9,095	71	472	234	198	1,390	1,689	2,307	3,699	3,105	334	**29,144**
19	White Marsh	264	1,801	-29	143	13	66	165	212	267	254	68	955	-36	145	-41	717	322	0	4,182	2,180	1,461	713	268	238	63	3,597	1,055	246	**19,289**
20	NE Balt Co	605	479	-33	171	23	71	155	194	326	348	132	732	84	330	45	1,455	-93	215	1,408	5,466	2,750	306	660	698	373	9,974	1,919	-96	**28,697**
21	Essex	531	1,786	-52	1	-50	37	214	549	224	71	-577	1,011	-280	253	-47	1,575	-182	-257	1,631	2,688	9,246	1,290	-317	-392	287	6,298	1,306	-58	**26,786**
22	Dundalk	135	2,053	-14	27	-141	22	139	472	266	614	-1,013	4,055	-854	-170	-133	316	-11	-183	847	498	2,873	5,283	-744	-587	44	2,021	-991	-408	**14,416**
23	BWI/Glen Burnie	63	-77	8	-24	40	-15	109	436	116	58	142	-362	-87	169	-28	94	-141	-143	-367	-305	-519	-1,509	15,451	17,754	6	-51	4,607	-1,713	**33,712**
24	AA Co	-527	-136	-22	-205	-74	-40	-173	-1,859	-498	86	-520	-358	-721	-235	-445	-88	-606	-622	-787	-655	-1,048	-3,429	13,994	188,675	-33	-49	16,547	4,461	**210,633**
25	Caroll Co	784	131	27	-101	68	24	34	-173	-119	157	258	196	499	977	1,458	5,271	417	1,628	54	276	387	78	2,257	4,552	78,395	632	15,726	17,798	**131,691**
26	Harford Co	155	1,987	91	285	-13	53	37	-1,445	-273	386	-301	792	-246	-62	-209	-336	-1,090	-1,187	-758	634	283	-362	660	624	13	180,631	1,166	-1,010	**180,505**
27	Howard Co	501	81	-15	-95	81	-17	-164	-1,902	-300	112	279	91	-941	-2,709	316	1,252	-15	-150	-115	-59	-316	-548	7,265	31,264	2,915	303	146,274	14,184	**197,572**
28	External	541	88	-399	-2	-83	134	-608	-574	286	203	903	260	-711	621	-217	149	37	-150	-116	-118	-203	-248	6,433	35,751	15,094	2,325	65,046	0	**124,442**
	Total	**9,950**	**15,469**	**-1,923**	**1,686**	**-909**	**-1,623**	**10,256**	**28,597**	**11,212**	**8,237**	**8,862**	**18,262**	**1,092**	**7,639**	**12,967**	**51,396**	**7,723**	**13,515**	**10,180**	**13,319**	**16,545**	**1,573**	**71,016**	**305,048**	**108,727**	**219,552**	**302,939**	**30,117**	**1,281,424**

Markets	Summary	Percent of Total	Percent Change from 2005	Notes
Attractions to the CBD	16,554	23%	7%	All Region to Districts 8 and 9
Attractions to SSA	4,509	6%	4%	All Region to Distrcit 14
Attractions to the Bay View Medical Center	13,246	18%	24%	All Region to District 12
Residents who live and travel in the corridor	38,249	53%	14%	Within Corridor
Total Markets	72,558	6%	10%	
Total Region	1,281,424		17%	

3 SUMMARY OF ALTERNATIVES

This section summarizes the definition of the alternatives that are evaluated in this document using the Red Line Travel Forecasting Model. Definitions for the No-Build, Low-Cost, and Locally Preferred Alternatives include a description of changes in both the highway and transit components of each alternative.

3.1 No-Build Alternative

The No-Build Alternative represents the future conditions of transportation facilities and services in 2035 if the Red Line is not built. This alternative provides a baseline by which the impacts and benefits of the Low-Cost Alternative are compared. The No-Build Alternative consists of the transit service levels, highway networks, and forecasted demographics for the year 2035 that are projected in the 2007 Baltimore Regional Transportation Board's Constrained Long Range Plan (CLRP), Transportation Outlook 2035.

3.1.1 Highway Improvements

The No-Build Alternative includes existing transit and highway facilities and committed transportation projects anticipated to be operational by 2035. Committed transportation projects are those identified in the BMC Constrained Long Range Transportation Plan (CLRP). Highway elements of the No-Build Alternative also are included in the Build Alternatives. Within the corridor, the following projects are included in the CLRP:

- Widen Boston Street from 2 to 4 lanes between Conkling Street and Ponca Street. Completion date 2013.
- Add a partial interchange at I-83 and MLK, adding northbound and southbound ramps. Completion date 2020.

3.1.2 Transit Improvements – Region

The No-Build Alternative would include an increase in bus fleet size to accommodate growth, allowing service frequencies to remain the same as today to accommodate longer bus travel times due to increased congestion. The CLRP includes the Red Line as one of the planned transit improvements. In the analysis of the No-Build Alternative for this study, the Red Line project was removed from the travel demand model networks, with bus service in the corridor as similar as what it is today. Route 40 and all other existing corridor routes are present in the No-Build with the Red Line removed.

The regional transit network for the 2035 BMC CLRP is illustrated in Figure 5.

Figure 5 – Regional Transit Network – 2035

3.1.3 Transit Improvements – Red Line Corridor

Under the No-Build Alternative, transit service within the Red Line Corridor would remain unchanged except for an increase in bus fleet size to accommodate growth. As seen in Table 7, the service frequencies would remain the same as today.

Due to the dependency on bus transit for east-west travel, and the congested and discontinuous nature of the roadway system for east-west travel, opportunities to make substantial improvements to transit travel times and reliability are limited.

There is, therefore, no transit improvements planned in the corridor that would significantly affect travel patterns, mode shares, and service levels by 2035. The CLRP therefore provides little, if any, relief to the anticipated congestion and growing demand within the corridor.

Table 7 – Red Line Corridor Existing and 2035 No-Build Transit Network

Route	Peak Headway		Off-Peak Headway	
	Existing	No-Build Alternative	Existing	No-Build Alternative
15	10	10	15	15
20	15	15	15	15
23	15	15	15	15
40	10	10	10	10

3.2 Low-Cost Alternative

The Low-Cost Alternative uses existing but improved technology and modes already in use by the transit agency in order to improve service and maximize efficiency in the Red Line Corridor. This alternative includes operating dedicated lanes on Eastern Avenue and Fleet Street during peak hours with the elimination of parking during those periods. On parts of Edmondson Avenue, parking would be eliminated during peak hours to create a dedicated lane. The Low-Cost Alternative includes the addition of a new bus route, T1, that operates at the same frequency as proposed for the Red Line rail service, with service frequencies of every 7 minutes during peak hours and every 10 minutes during off-peak hours. The route serves the same areas proposed for the Red Line Project Corridor–operating between the Centers for Medicare and Medicaid Services (CMS) and the Bayview MARC Station–and provides transfers to all the routes that are proposed to feed the LRT stations in these areas.

In the Low-Cost Alternative, the Red Line Project feeder bus routes are realigned as planned under the LRT alternative and feed the T1 bus route, rather than the Red Line, in the areas of the proposed rail stations. In this alternative, the T1 bus route will serve as the main transportation mode along this corridor. Peak period service on QuickBus Route 40 will be eliminated and replaced by Route T2, which combined with Route T1 provide a 5-minute headway during the peak period. The same operating plan is planned in the Red Line LRT

Alternative. A summary of the bus service changes between the No-Build and the Low-Cost Alternative is provided in Table 8.

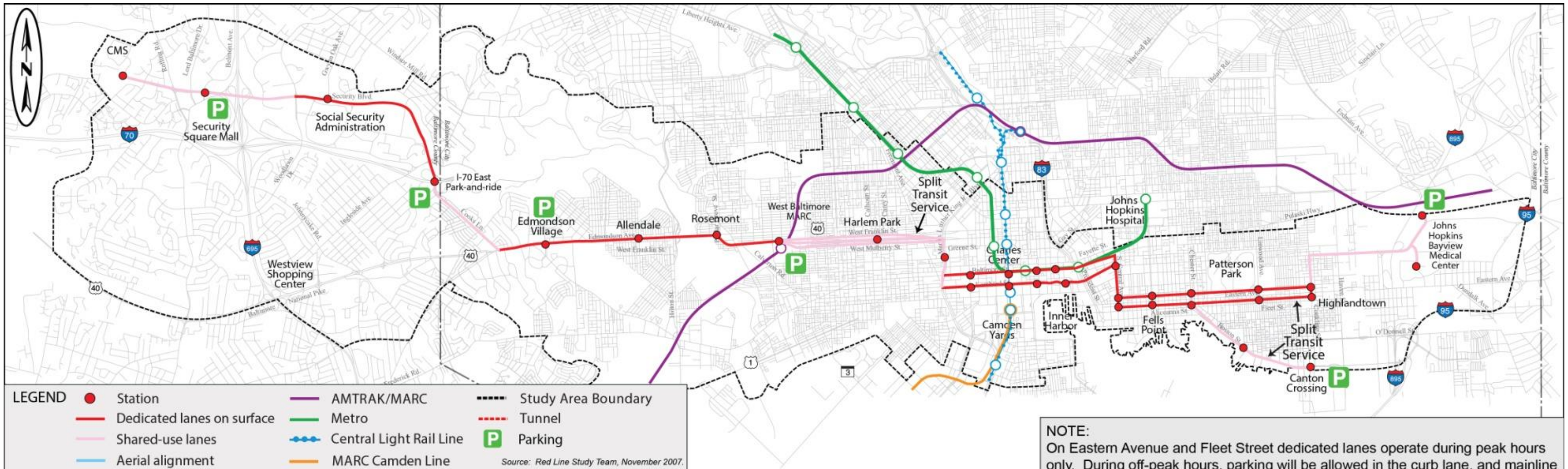
Table 8 – Bus Service Changes for Low-Cost Alternative – 2035

Route	Peak Headway		Off-Peak Headway	
	No-Build Alternative	Low-Cost Alternative	No-Build Alternative	Low-Cost Alternative
15	10	10	15	15
20	15	15	15	15
23	15	15	15	15
40	10	Eliminated	10	10
T1	n/a	7	n/a	10
T2	n/a	14	n/a	n/a

The modifications to the feeder bus service for the Low-Cost Alternative, shown in Figure 6, would simplify the route structure included in the No-Build Alternative, extend the service area, and improve service frequencies where appropriate. During peak periods, most of the radial feeder bus routes will operate locally when off the trunk line streets and, once on the trunk line (generally US 40 on the west side, Baltimore/Lombard Streets downtown, and Eastern/Fleet Streets on the east side) will operate as limited-stop service, making stops only at proposed trunk line stations. Local stops would continue to be served by local bus service operating at 15-minute headways.

The Low-Cost Alternative is illustrated in Figure 6.

Figure 6 – Red Line Low-Cost Alternative



NOTE:
On Eastern Avenue and Fleet Street dedicated lanes operate during peak hours only. During off-peak hours, parking will be allowed in the curb lane, and mainline service buses will travel in the general purpose lanes.

On parts of Edmondson Avenue where on-street parking serves residential or business parking needs, a dedicated lane will be available in the curb lane during peak hours in the peak direction only; during off-peak periods, buses would operate in shared lanes.

3.3 Locally Preferred Alternative (LPA)

The recommended LPA Alternative is a 14-mile light rail line that will extend from the Woodlawn area in Baltimore County to the Johns Hopkins Bayview Medical Campus in east Baltimore City. The typical cross-section has a dedicated surface transitway in the median of existing roads with one mile of tunnel under Cooks Lane and approximately three miles of tunnel downtown.

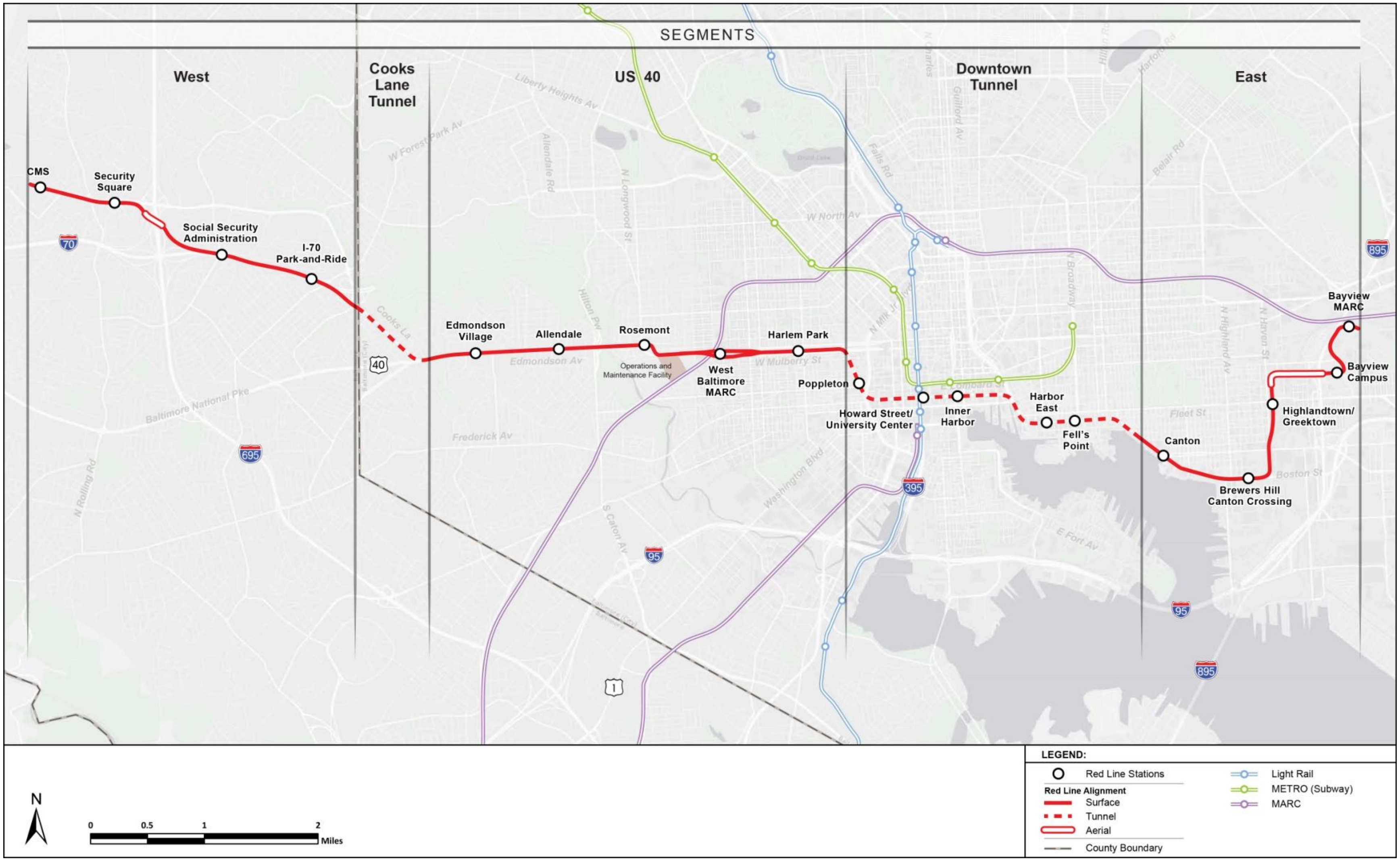
The light rail line will have 19 stations, with Park-and-Ride facilities at five of the stations. Similar to the Low-Cost Alternative, the frequency of service with the Red Line LRT will be 7 minutes headway during peak period and 10 minutes during off-peak period. The alignment and station locations of the LPA alignment considered in this study are illustrated in Figure 7 based on the operating plan summarized in Table 9.

Table 9 – Red Line LPA Operating Plan

No.	Station	Running Time (minutes)	Distance (feet)
1	CMS Station	3	3,530
2	Security Square Station	3	5,780
3	Social Security Administration Station	2	4,320
4	I-70 Park-and-Ride Station	3	8,970
5	Edmondson Village Station	3	4,000
6	Allendale Station	3	3,830
7	Rosemont Station	3	3,610
8	West Baltimore MARC Station	3	3,890
9	Harlem Park Station	2	4,640
10	Poppleton Station	2	1,990
11	Howard Street/University Center Station	1	2,210
12	Inner Harbor Station	2	4,200
13	Harbor East Station	1	1,620
14	Fells Point Station	2	4,820
15	Canton Station	3	4,200
16	Brewers Hill/Canton Crossing Station	3	4,280
17	Highlandtown/Greektown Station	2	4,370
18	Bayview Campus Station	2	3,210
19	Bayview MARC Station	-	-
Total		43	73,500

The majority of the feeder bus service operating in the Red Line alternative terminates at a guideway station, requiring passengers to transfer. Existing bus routes parallel to the proposed LPA alignment would be terminated at a LRT station, with some local service continuing to be operated to serve local stops. No buses would share the LRT tunnel through downtown or under Cooks Lane.

Figure 7 - Red Line LRT LPA



4 THE FORECASTS

Travel forecasts provide a wide range of information used for analysis of the proposed alternatives. These estimates include measures such as mode shares, mode of access, user benefits, station boardings, vehicle-hours and vehicle-miles, and average daily volumes are reported in other reports such as the environmental Impact Statement. The results presented in this section focus on information not provided in other reports and are mainly used for development of the Case for the Project. This section includes information on 2035 conditions on person and transit trips with and without the projects, ridership levels, and benefits of the Low-Cost and the Locally Preferred Alternative.

There are special market rail trips (circulation trips) that are generated when a rail system becomes available to the transit user because of the rail's visibility, reliability, and ease of use. A non-home-based-direct demand model was developed in 1989 for estimating these special circulation trips for the Washington Metro Area Transit Authority (WMATA). This model estimates the number of non-home-based-trip ends at each rail station. The model was updated and re-estimated using 2005 WMATA Rail Survey data.

The forecast runs summarized in this section include the trips from the special rail market. In the Low-Cost Alternative, 11,010 circulation trips are produced, resulting in an overall 244,400 transit trips. In the LPA, approximately 18,600 circulation trips are produced, resulting in total transit trips of 264,240 per day. In both scenarios, the circulation trips represent just fewer than 5 percent of the total daily rail ridership. For the No-Build Alternative, the total daily transit trips are 237,600, including 10,640 circulation rail trips.

4.1 Design Year (2035) without the Project (No-Build Alternative)

Within the Red Line Corridor, no changes to the transit service are planned over the next three decades. Similarly, the highway network will remain relatively unchanged.

In contrast, increases in population and modest increases in employment are projected to occur by the year 2035. Therefore, while the demand for transportation service will increase due to demographic growth, the transportation system will not keep up with the expected needs. Using the same format as shown in Figure 4, the 2005 and 2035 transit trips were aggregated by district. The summaries are provided in tables 10 and 11 and were used to identify the size of each of the four major travel markets in the corridor. Table 12 displays the differences between 2035 and 2005.

Transit usage in the markets served by the corridor is expected to increase by approximately 22,800 trips per day between 2005 (77,700) and 2035 (100,500). In 2035, of the total Red Line Corridor market share of 100,500 transit trips, approximately 52,400 trips are attracted to the Baltimore CBD, 2,500 to the Social Security Administration area, 3,200 to the Bayview Medical Center, and 42,400 trips are from residents who live and travel in the corridor.

Table 10 – 2005 Transit Trips by District

Productions	District	Attractions 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total
1	**NW Balt City**	6,303	582	319	1,135	187	303	1,449	6,115	2,310	330	772	217	264	483	699	1,004	1,309	864	88	13	185	114	227	30	0	0	66	646	**26,014**
2	**NE Balt City**	868	1,766	328	692	35	55	452	2,900	941	162	296	253	96	138	74	242	1,003	259	396	26	231	179	84	16	0	0	18	659	**12,169**
3	**Waverly**	509	361	478	410	14	56	148	1,033	313	36	104	72	38	35	40	116	388	115	56	6	41	42	35	4	0	0	6	386	**4,842**
4	**Greenmont**	929	506	273	1,599	38	60	316	2,043	1,005	140	213	159	83	71	71	181	507	234	104	10	98	130	62	6	0	0	11	342	**9,191**
5	**Edmond. Vill.**	305	44	31	150	383	180	187	1,150	306	70	371	50	178	242	69	74	92	74	11	1	28	34	67	11	0	0	31	356	**4,495**
6	**Rosemont**	629	79	37	125	184	407	450	1,353	315	94	333	61	125	138	59	75	111	68	12	1	23	34	66	9	0	0	17	151	**4,956**
7	**Poppleton**	1,221	205	72	370	135	301	1,511	3,500	752	144	516	119	157	160	150	240	302	202	20	3	50	67	142	15	0	0	31	773	**11,158**
8	**CBD**	630	73	22	215	30	44	435	2,319	724	109	271	40	84	45	136	148	196	107	18	1	26	37	141	9	0	0	22	881	**6,763**
9	**East CBD**	673	258	68	469	32	51	386	2,381	1,431	297	229	142	62	46	108	161	230	146	63	5	85	129	67	4	0	0	11	237	**7,771**
10	**Canton**	353	186	42	245	32	40	171	1,679	888	937	198	410	61	39	34	140	159	135	69	7	113	222	74	16	0	0	29	515	**6,794**
11	**S Balt City**	581	107	46	259	245	158	504	2,722	510	172	1,771	131	440	168	98	130	176	119	33	3	41	92	486	51	0	0	63	821	**9,927**
12	**E Balt City**	71	87	21	86	9	12	43	369	146	153	70	462	24	26	12	47	67	43	44	3	77	299	22	2	0	0	4	37	**2,236**
13	**Cantonsville**	364	50	21	97	196	142	257	1,679	286	81	769	61	1,048	393	143	137	207	152	26	3	47	40	269	40	0	0	128	671	**7,307**
14	**SSA/Sec. Sqr.**	248	19	11	48	123	63	124	738	190	20	152	30	195	504	128	52	77	49	5	1	18	18	37	6	0	0	52	385	**3,293**
15	**Randallstown**	1,470	99	71	246	101	105	530	2,947	857	71	289	79	177	417	786	404	276	225	26	6	114	42	122	17	0	0	73	549	**10,099**
16	**Owings Mills**	1,107	125	34	275	31	40	392	2,695	783	110	223	214	97	98	286	936	404	324	119	9	193	106	125	18	0	0	21	228	**8,993**
17	**Towson/Luther.**	868	452	140	304	15	27	224	1,920	482	56	165	77	74	96	100	279	3,091	543	141	9	140	40	108	10	0	0	21	258	**9,640**
18	**Hunt Val./N Balt**	289	43	11	103	10	13	146	1,122	236	39	103	62	60	44	49	121	338	550	31	2	44	27	111	15	0	0	26	110	**3,705**
19	**White Marsh**	181	384	45	150	9	12	96	692	216	51	114	105	48	49	27	140	392	182	319	16	181	62	50	6	0	0	15	228	**3,770**
20	**NE Balt Co**	107	59	8	44	6	4	45	466	76	17	58	24	33	36	21	144	116	267	32	6	26	9	53	9	0	1	19	226	**1,912**
21	**Essex**	353	253	30	175	17	19	136	1,052	322	110	141	197	73	111	76	452	412	360	262	12	648	197	61	10	0	0	18	347	**5,844**
22	**Dundalk**	172	183	40	187	21	26	92	999	372	211	196	808	66	79	40	194	167	156	89	5	169	877	68	8	0	0	12	265	**5,502**
23	**BWI/Glen Burnie**	295	35	8	80	53	43	213	1,132	234	48	595	38	191	78	91	89	126	125	11	1	21	25	1,011	278	0	0	42	1,022	**5,885**
24	**AA Co**	145	19	7	54	34	28	144	1,403	151	40	351	24	178	61	38	48	85	118	11	1	19	23	920	1,568	0	0	74	5,254	**10,798**
25	**Caroll Co**	41	2	1	14	2	1	25	279	40	4	26	4	9	14	27	43	15	17	2	0	14	1	22	3	0	0	5	27	**638**
26	**Harford Co**	110	20	9	73	12	8	68	1,145	221	29	132	47	47	89	18	158	94	67	15	1	14	13	63	5	0	1,008	21	481	**3,968**
27	**Howard Co**	153	15	10	59	49	35	109	1,499	194	29	164	20	86	65	24	31	67	91	7	1	8	8	110	41	0	0	3,001	3,741	**9,617**
28	**External**	165	29	28	105	35	33	149	1,011	175	36	160	18	118	66	58	55	80	150	18	3	39	17	133	69	0	0	293	0	**3,043**
	Total	**19,140**	**6,041**	**2,211**	**7,769**	**2,038**	**2,266**	**8,802**	**48,343**	**14,476**	**3,596**	**8,782**	**3,924**	**4,112**	**3,791**	**3,462**	**5,841**	**10,487**	**5,742**	**2,028**	**155**	**2,693**	**2,884**	**4,736**	**2,276**	**0**	**1,009**	**4,130**	**19,596**	**200,330**

Markets	Summary	Percent of Total	Notes
Attractions to the CBD	44,578	57%	All Region to Districts 8 and 9
Attractions to SSA	2,591	3%	All Region to Distrcit 14
Attractions to the Bay View Medical Center	2,610	3%	All Region to District 12
Residents who live and travel in the corridor	27,912	36%	Within Corridor
Total Markets	77,691	39%	
Total Region	200,330		

Table 11 – 2035 No-Build Alternative Transit Trips by District

Productions	District	Attractions 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total
1	NW Balt City	5,393	583	267	1,118	186	312	2,023	9,203	2,658	423	909	305	371	608	573	1,238	1,306	1,040	96	15	204	133	443	75	0	0	230	1,239	**30,951**
2	NE Balt City	750	1,410	241	553	30	57	587	3,419	855	160	269	269	87	134	64	337	861	254	375	26	219	176	145	30	0	0	43	460	**11,811**
3	Waverly	471	321	414	383	16	80	276	1,692	321	36	128	95	56	46	50	207	403	135	61	7	44	44	83	9	0	0	20	330	**5,728**
4	Greenmont	896	507	246	1,522	45	69	384	2,657	1,009	150	259	205	114	86	59	282	544	281	123	11	102	133	118	21	0	0	52	296	**10,171**
5	Edmond. Vill.	225	39	23	121	284	127	201	1,203	271	66	300	47	160	163	49	83	79	59	7	1	18	24	104	18	0	0	63	263	**3,998**
6	Rosemont	615	93	36	115	152	356	510	1,640	317	104	318	74	145	126	58	104	124	70	13	1	22	35	142	29	0	0	52	200	**5,451**
7	Poppleton	2,069	518	156	713	270	533	3,243	6,418	1,452	396	1,099	336	384	366	188	442	589	357	50	6	109	164	536	105	0	0	299	501	**21,299**
8	CBD	841	124	26	202	33	53	682	4,564	1,138	170	390	51	193	58	112	188	269	360	27	2	37	45	529	50	0	0	145	820	**11,109**
9	East CBD	1,044	560	124	746	62	128	696	4,336	2,617	662	588	327	204	130	88	289	437	289	123	9	147	238	230	55	0	0	208	314	**14,651**
10	Canton	313	167	30	197	28	33	206	1,828	775	884	183	378	62	32	29	183	141	126	67	6	104	202	125	31	0	0	73	325	**6,528**
11	S Balt City	532	114	43	237	207	135	596	2,937	512	207	1,527	160	449	151	87	163	175	130	31	2	36	78	852	114	0	0	227	335	**10,037**
12	E Balt City	138	187	35	147	12	23	89	565	241	282	166	940	59	41	23	144	135	81	90	6	134	582	107	22	0	0	56	63	**4,368**
13	Cantonsville	327	50	17	78	165	109	243	1,740	275	83	613	60	848	323	119	144	170	136	23	2	34	32	390	71	0	0	236	682	**6,970**
14	SSA/Sec. Sqr.	221	19	9	41	96	49	129	760	171	20	131	26	180	449	114	62	75	40	6	1	13	9	56	10	0	0	96	329	**3,112**
15	Randallstown	1,207	106	68	217	86	100	555	3,339	849	93	279	104	175	390	626	362	240	203	26	6	97	43	187	29	0	0	169	929	**10,485**
16	Owings Mills	932	162	32	289	33	45	409	3,117	874	182	252	474	108	109	183	1,043	413	306	146	10	194	127	196	33	0	0	52	372	**10,093**
17	Towson/Luther.	738	429	118	293	17	32	263	2,567	514	81	188	118	93	113	66	397	3,030	598	156	10	159	48	169	24	0	0	59	590	**10,870**
18	Hunt Val./N Balt	394	50	10	102	13	19	254	1,642	311	62	153	109	103	49	54	165	346	782	34	3	43	31	286	33	0	0	62	264	**5,374**
19	White Marsh	176	354	36	142	7	13	123	743	217	56	114	116	50	48	24	191	394	162	294	14	163	59	109	15	0	0	30	389	**4,039**
20	NE Balt Co	118	58	7	45	5	6	66	556	82	23	74	32	45	34	20	198	108	227	26	5	22	9	134	23	0	4	54	276	**2,257**
21	Essex	331	231	23	146	11	18	192	1,335	302	100	162	188	100	96	64	640	394	335	235	11	573	174	161	23	0	0	53	458	**6,356**
22	Dundalk	156	153	29	154	11	23	106	1,060	336	199	205	756	75	49	35	253	155	129	84	5	162	717	172	20	0	0	32	259	**5,335**
23	BWI/Glen Burnie	253	30	8	48	44	35	218	1,368	235	52	489	37	184	49	61	73	102	172	7	1	12	15	1,106	272	0	0	75	412	**5,358**
24	AA Co	136	19	6	49	29	26	141	1,199	131	47	298	33	144	41	38	66	78	105	10	0	12	9	903	1,697	0	0	160	6,207	**11,584**
25	Caroll Co	45	3	1	11	2	1	21	226	32	6	23	6	10	16	23	42	14	14	2	0	11	1	38	7	0	0	17	36	**608**
26	Harford Co	136	21	9	78	12	13	82	1,040	211	48	190	83	72	58	14	224	100	91	12	0	9	11	197	22	0	1,256	60	373	**4,422**
27	Howard Co	169	17	10	58	46	32	110	1,422	185	33	142	29	62	49	24	45	76	84	10	1	11	9	157	76	0	0	3,256	4,755	**10,868**
28	External	194	33	24	116	28	36	112	1,017	165	46	175	28	107	44	44	57	80	110	12	2	26	14	248	215	0	0	642	0	**3,575**
	Total	**18,820**	**6,358**	**2,048**	**7,921**	**1,930**	**2,463**	**12,517**	**63,593**	**17,056**	**4,671**	**9,624**	**5,386**	**4,640**	**3,858**	**2,889**	**7,622**	**10,838**	**6,676**	**2,146**	**163**	**2,717**	**3,162**	**7,923**	**3,129**	**0**	**1,260**	**6,521**	**21,477**	**237,408**

Markets	Summary	Percent of Total	Notes
Attractions to the CBD	52,353	52%	All Region to Districts 8 and 9
Attractions to SSA	2,493	2%	All Region to Distrcit 14
Attractions to the Bay View Medical Center	3,207	3%	All Region to District 12
Residents who live and travel in the corridor	42,419	42%	Within Corridor
Total Markets	100,472	42%	
Total Region	237,408		

Table 12 – Difference in Transit Trips (2035 No-Build minus 2005)

Productions	District	Attractions 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total
1	NW Balt City	-910	1	-52	-17	-1	9	574	3,088	348	93	137	88	107	125	-126	234	-3	176	8	2	19	19	216	45	0	0	164	593	**4,937**
2	NE Balt City	-118	-356	-87	-139	-5	2	135	519	-86	-2	-27	16	-9	-4	-10	95	-142	-5	-21	0	-12	-3	61	14	0	0	25	-199	**-358**
3	Waverly	-38	-40	-64	-27	2	24	128	659	8	0	24	23	18	11	10	91	15	20	5	1	3	2	48	5	0	0	14	-56	**886**
4	Greenmont	-33	1	-27	-77	7	9	68	614	4	10	46	46	31	15	-12	101	37	47	19	1	4	3	56	15	0	0	41	-46	**980**
5	Edmond. Vill.	-80	-5	-8	-29	-99	-53	14	53	-35	-4	-71	-3	-18	-79	-20	9	-13	-15	-4	0	-10	-10	37	7	0	0	32	-93	**-497**
6	Rosemont	-14	14	-1	-10	-32	-51	60	287	2	10	-15	13	20	-12	-1	29	13	2	1	0	-1	1	76	20	0	0	35	49	**495**
7	Poppleton	848	313	84	343	135	232	1,732	2,918	700	252	583	217	227	206	38	202	287	155	30	3	59	97	394	90	0	0	268	-272	**10,141**
8	CBD	211	51	4	-13	3	9	247	2,245	414	61	119	11	109	13	-24	40	73	253	9	1	11	8	388	41	0	0	123	-61	**4,346**
9	East CBD	371	302	56	277	30	77	310	1,955	1,186	365	359	185	142	84	-20	128	207	143	60	4	62	109	163	51	0	0	197	77	**6,880**
10	Canton	-40	-19	-12	-48	-4	-7	35	149	-113	-53	-15	-32	1	-7	-5	43	-18	-9	-2	-1	-9	-20	51	15	0	0	44	-190	**-266**
11	S Balt City	-49	7	-3	-22	-38	-23	92	215	2	35	-244	29	9	-17	-11	33	-1	11	-2	-1	-5	-14	366	63	0	0	164	-486	**110**
12	E Balt City	67	100	14	61	3	11	46	196	95	129	96	478	35	15	11	97	68	38	46	3	57	283	85	20	0	0	52	26	**2,132**
13	Cantonsville	-37	0	-4	-19	-31	-33	-14	61	-11	2	-156	-1	-200	-70	-24	7	-37	-16	-3	-1	-13	-8	121	31	0	0	108	11	**-337**
14	SSA/Sec. Sqr.	-27	0	-2	-7	-27	-14	5	22	-19	0	-21	-4	-15	-55	-14	10	-2	-9	1	0	-5	-9	19	4	0	0	44	-56	**-181**
15	Randallstown	-263	7	-3	-29	-15	-5	25	392	-8	22	-10	25	-2	-27	-160	-42	-36	-22	0	0	-17	1	65	12	0	0	96	380	**386**
16	Owings Mills	-175	37	-2	14	2	5	17	422	91	72	29	260	11	11	-103	107	9	-18	27	1	1	21	71	15	0	0	31	144	**1,100**
17	Towson/Luther.	-130	-23	-22	-11	2	5	39	647	32	25	23	41	19	17	-34	118	-61	55	15	1	19	8	61	14	0	0	38	332	**1,230**
18	Hunt Val./N Balt	105	7	-1	-1	3	6	108	520	75	23	50	47	43	5	5	44	8	232	3	1	-1	4	175	18	0	0	36	154	**1,669**
19	White Marsh	-5	-30	-9	-8	-2	1	27	51	1	5	0	11	2	-1	-3	51	2	-20	-25	-2	-18	-3	59	9	0	0	15	161	**269**
20	NE Balt Co	11	-1	-1	1	-1	2	21	90	6	6	16	8	12	-2	-1	54	-8	-40	-6	-1	-4	0	81	14	0	3	35	50	**345**
21	Essex	-22	-22	-7	-29	-6	-1	56	283	-20	-10	21	-9	27	-15	-12	188	-18	-25	-27	-1	-75	-23	100	13	0	0	35	111	**512**
22	Dundalk	-16	-30	-11	-33	-10	-3	14	61	-36	-12	9	-52	9	-30	-5	59	-12	-27	-5	0	-7	-160	104	12	0	0	20	-6	**-167**
23	BWI/Glen Burnie	-42	-5	0	-32	-9	-8	5	236	1	4	-106	-1	-7	-29	-30	-16	-24	47	-4	0	-9	-10	95	-6	0	0	33	-610	**-527**
24	AA Co	-9	0	-1	-5	-5	-2	-3	-204	-20	7	-53	9	-34	-20	0	18	-7	-13	-1	-1	-7	-14	-17	129	0	0	86	953	**786**
25	Caroll Co	4	1	0	-3	0	0	-4	-53	-8	2	-3	2	1	2	-4	-1	-1	-3	0	0	-3	0	16	4	0	0	12	9	**-30**
26	Harford Co	26	1	0	5	0	5	14	-105	-10	19	58	36	25	-31	-4	66	6	24	-3	-1	-5	-2	134	17	0	248	39	-108	**454**
27	Howard Co	16	2	0	-1	-3	-3	1	-77	-9	4	-22	9	-24	-16	0	14	9	-7	3	0	3	1	47	35	0	0	255	1,014	**1,251**
28	External	29	4	-4	11	-7	3	-37	6	-10	10	15	10	-11	-22	-14	2	0	-40	-6	-1	-13	-3	115	146	0	0	349	0	**532**
	Total	**-320**	**317**	**-163**	**152**	**-108**	**197**	**3,715**	**15,250**	**2,580**	**1,075**	**842**	**1,462**	**528**	**67**	**-573**	**1,781**	**351**	**934**	**118**	**8**	**24**	**278**	**3,187**	**853**	**0**	**251**	**2,391**	**1,881**	**37,078**

Markets	Summary	Percent of Total	Percent Change from 2005	Notes
Attractions to the CBD	7,775	34%	17%	All Region to Districts 8 and 9
Attractions to SSA	-98	0%	-4%	All Region to Distrcit 14
Attractions to the Bay View Medical Center	597	3%	23%	All Region to District 12
Residents who live and travel in the corridor	14,507	64%	52%	Within Corridor
Total Markets	22,781	61%	29%	
Total Region	37,078			

4.2 Impacts of the Low-Cost Alternative

The Low-Cost Alternative attempts to provide the needed improvements to the transportation system without a major capital investment. The following sections summarize the impacts of the Low-Cost Alternative on transit trips, travel time, and daily hours of user benefits when compared to the No-Build Alternative.

4.2.1 Transit Trips in the Low-Cost Alternative

With the proposed enhancement to the No-Build transit system, the Low-Cost Alternative would increase the number of transit trips in the markets serving the corridor by less than 4 percent. Of the 103,700 transit trips serving the corridor's markets, 52,700 per day would be attracted to the CBD area from the region. The Social Security Administration and the Bayview Medical Center both attract a similar number of transit trips, 3,400 and 3,600 per day, respectively. Transit trips by residents who live and travel in the corridor represent 42 percent of the corridor's market share, approximately 44,000 transit trips per day. Transit trips with the Low-Cost Alternative are summarized in Table 13. Table 14 shows the difference in transit trips by district between the Low-Cost Alternative and the No-Build Alternative for 2035.

Compared to the No-Build Alternative, the largest increase in transit trips with the Low-Cost Alternative would occur in trips to the Social Security Administration market, with a 35 percent increase or approximately 860 trips. The next travel market segment that would see an increase in transit trips with the Low-Cost Alternative is the trips attracted to the Bayview Medical Center, which would increase by 420 trips or 13 percent as shown in Figure 8.

Figure 8 – Increase in Transit Trips by Travel Market (Low-Cost minus No-Build)

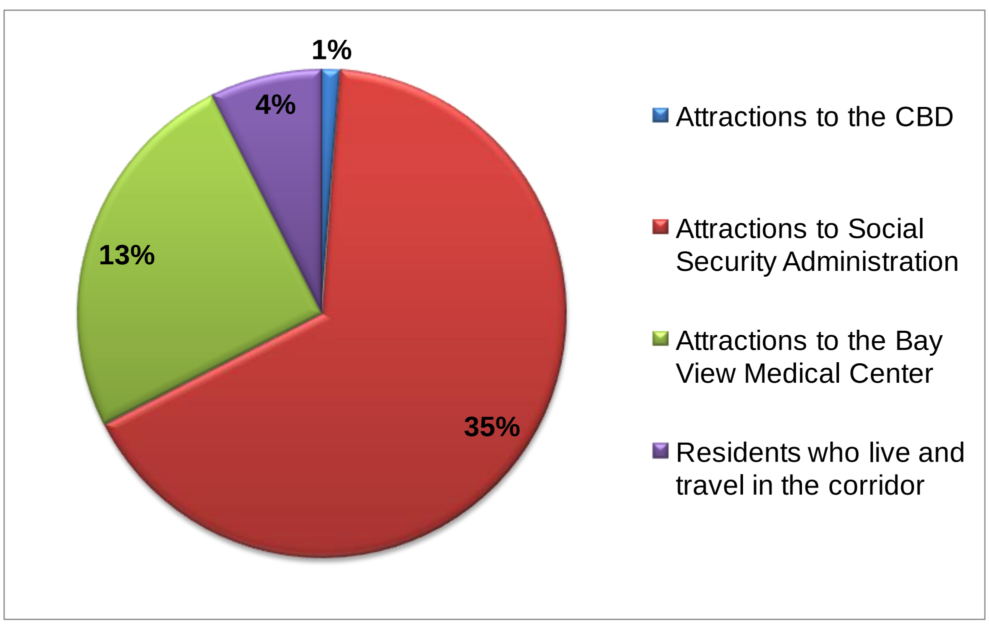


Table 13 – 2035 Low-Cost Alternative Person Trips by District

Productions	District	Attractions 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total
1	**NW Balt City**	5,395	589	267	1,120	210	319	2,016	9,210	2,699	479	915	340	434	700	650	1,237	1,305	1,044	97	15	205	137	444	76	0	0	283	1,239	**31,425**
2	**NE Balt City**	758	1,417	241	562	33	57	594	3,418	875	168	277	303	105	147	77	346	867	254	380	26	222	174	144	30	0	0	48	460	**11,983**
3	**Waverly**	471	322	414	383	17	81	277	1,689	323	38	131	99	66	51	58	207	401	135	62	7	44	43	83	9	0	0	22	330	**5,763**
4	**Greenmont**	898	512	246	1,522	48	69	386	2,656	1,012	155	260	213	129	100	67	284	541	281	125	11	101	126	117	21	0	0	57	296	**10,233**
5	**Edmond. Vill.**	250	47	26	136	309	144	222	1,323	311	87	346	62	203	224	70	90	86	58	8	1	22	28	115	20	0	0	82	268	**4,538**
6	**Rosemont**	623	93	37	115	170	366	523	1,713	324	130	342	88	166	166	72	106	123	67	13	1	23	37	146	31	0	0	71	222	**5,768**
7	**Poppleton**	2,076	521	158	714	286	544	3,267	6,468	1,469	434	1,103	370	413	421	212	444	587	355	50	6	110	168	539	106	0	0	348	503	**21,672**
8	**CBD**	839	123	26	200	37	55	684	4,605	1,123	192	386	58	203	82	119	188	268	360	27	2	37	45	529	50	0	0	156	828	**11,222**
9	**East CBD**	1,046	564	124	744	66	128	700	4,314	2,622	676	587	345	219	150	95	290	434	289	124	9	146	235	230	55	0	0	239	315	**14,746**
10	**Canton**	323	169	31	196	32	38	213	1,834	771	930	190	425	74	49	37	191	139	118	69	6	107	210	122	30	0	0	95	335	**6,734**
11	**S Balt City**	531	113	43	231	226	144	601	2,907	511	231	1,534	173	507	200	103	163	172	129	32	3	36	77	858	115	0	0	257	340	**10,237**
12	**E Balt City**	138	185	34	141	13	24	92	570	238	313	168	1,008	64	51	27	146	128	74	88	6	130	576	104	20	0	0	64	65	**4,467**
13	**Cantonsville**	347	53	18	82	188	119	252	1,799	293	100	665	71	1,009	430	154	150	177	136	25	3	37	34	421	74	0	0	293	672	**7,602**
14	**SSA/Sec. Sqr.**	261	27	12	52	114	60	155	884	214	35	175	43	271	687	185	70	96	46	8	1	19	15	87	14	0	0	134	334	**3,999**
15	**Randallstown**	1,274	115	73	230	109	112	582	3,445	896	115	304	124	233	548	774	385	260	214	28	7	103	46	199	31	0	0	219	955	**11,381**
16	**Owings Mills**	934	165	32	289	37	47	411	3,127	891	218	257	536	127	132	208	1,043	410	306	148	10	194	127	196	34	0	0	64	405	**10,348**
17	**Towson/Luther.**	740	433	118	293	18	33	265	2,565	516	87	191	124	109	130	77	398	3,057	599	156	10	158	46	169	24	0	0	67	590	**10,973**
18	**Hunt Val./N Balt**	395	51	10	102	14	19	255	1,637	310	69	157	110	117	61	59	165	348	782	35	3	41	28	286	33	0	0	68	264	**5,419**
19	**White Marsh**	177	360	36	144	8	13	123	743	224	61	122	136	62	56	30	195	386	150	294	14	164	61	109	15	0	0	38	390	**4,111**
20	**NE Balt Co**	117	58	7	45	6	6	64	553	84	29	80	43	58	46	24	199	104	214	26	5	23	11	130	22	0	4	68	276	**2,302**
21	**Essex**	318	235	22	137	13	19	166	1,249	294	123	173	220	127	127	79	633	378	282	235	11	569	178	158	22	0	0	74	469	**6,311**
22	**Dundalk**	139	151	28	138	13	23	95	962	308	241	198	857	87	69	41	211	132	75	85	5	166	729	151	18	0	0	39	253	**5,214**
23	**BWI/Glen Burnie**	254	29	8	47	50	36	220	1,370	236	57	510	38	217	77	70	73	101	172	7	1	12	13	1,107	272	0	0	84	409	**5,470**
24	**AA Co**	138	18	6	48	38	28	145	1,225	140	55	314	36	185	81	52	66	77	105	10	0	12	9	908	1,693	0	0	184	6,169	**11,742**
25	**Caroll Co**	45	3	1	11	3	1	21	228	33	8	24	7	13	19	27	42	14	14	2	0	11	1	38	7	0	0	20	46	**639**
26	**Harford Co**	137	22	9	78	15	14	83	1,035	219	64	202	122	87	95	19	226	98	91	13	0	9	12	194	23	0	1,255	80	373	**4,575**
27	**Howard Co**	239	29	13	69	113	54	143	1,529	232	56	183	37	156	194	92	56	96	87	15	1	15	12	154	80	0	0	3,289	4,700	**11,644**
28	**External**	201	34	24	116	38	38	119	1,057	175	62	194	38	148	92	71	67	81	110	13	2	30	17	254	219	0	0	683	0	**3,883**
	Total	**19,064**	**6,438**	**2,064**	**7,945**	**2,224**	**2,591**	**12,674**	**64,115**	**17,343**	**5,213**	**9,988**	**6,026**	**5,589**	**5,185**	**3,549**	**7,671**	**10,866**	**6,547**	**2,175**	**166**	**2,746**	**3,195**	**7,992**	**3,144**	**0**	**1,259**	**7,126**	**21,506**	**244,401**

Markets	Summary	Percent of Total	Notes
Attractions to the CBD	52,675	51%	All Region to Districts 8 and 9
Attractions to SSA	3,355	3%	All Region to Distrcit 14
Attractions to the Bay View Medical Center	3,627	3%	All Region to District 12
Residents who live and travel in the corridor	44,051	42%	Within Corridor
Total Markets	103,708	42%	
Total Region	244,401		

Table 14 – Difference in Transit Trips (2035 Low-Cost Alternative minus No-Build)

	District	Attractions																												Total
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	
Productions	**1 NW Balt City**	2	6	0	2	24	7	-7	7	41	56	6	35	63	92	77	-1	-1	4	1	0	1	4	1	1	0	0	53	0	**474**
	2 NE Balt City	8	7	0	9	3	0	7	-1	20	8	8	34	18	13	13	9	6	0	5	0	3	-2	-1	0	0	0	5	0	**172**
	3 Waverly	0	1	0	0	1	1	1	-3	2	2	3	4	10	5	8	0	-2	0	1	0	0	-1	0	0	0	0	2	0	**35**
	4 Greenmont	2	5	0	0	3	0	2	-1	3	5	1	8	15	14	8	2	-3	0	2	0	-1	-7	-1	0	0	0	5	0	**62**
	5 Edmond. Vill.	25	8	3	15	25	17	21	120	40	21	46	15	43	61	21	7	7	-1	1	0	4	4	11	2	0	0	19	5	**540**
	6 Rosemont	8	0	1	0	18	10	13	73	7	26	24	14	21	40	14	2	-1	-3	0	0	1	2	4	2	0	0	19	22	**317**
	7 Poppleton	7	3	2	1	16	11	24	50	17	38	4	34	29	55	24	2	-2	-2	0	0	1	4	3	1	0	0	49	2	**373**
	8 CBD	-2	-1	0	-2	4	2	2	41	-15	22	-4	7	10	24	7	0	-1	0	0	0	0	0	0	0	0	0	11	8	**113**
	9 East CBD	2	4	0	-2	4	0	4	-22	5	14	-1	18	15	20	7	1	-3	0	1	0	-1	-3	0	0	0	0	31	1	**95**
	10 Canton	10	2	1	-1	4	5	7	6	-4	46	7	47	12	17	8	8	-2	-8	2	0	3	8	-3	-1	0	0	22	10	**206**
	11 S Balt City	-1	-1	0	-6	19	9	5	-30	-1	24	7	13	58	49	16	0	-3	-1	1	1	0	-1	6	1	0	0	30	5	**200**
	12 E Balt City	0	-2	-1	-6	1	1	3	5	-3	31	2	68	5	10	4	2	-7	-7	-2	0	-4	-6	-3	-2	0	0	8	2	**99**
	13 Cantonsville	20	3	1	4	23	10	9	59	18	17	52	11	161	107	35	6	7	0	2	1	3	2	31	3	0	0	57	-10	**632**
	14 SSA/Sec. Sqr.	40	8	3	11	18	11	26	124	43	15	44	17	91	238	71	8	21	6	2	0	6	6	31	4	0	0	38	5	**887**
	15 Randallstown	67	9	5	13	23	12	27	106	47	22	25	20	58	158	148	23	20	11	2	1	6	3	12	2	0	0	50	26	**896**
	16 Owings Mills	2	3	0	0	4	2	2	10	17	36	5	62	19	23	25	0	-3	0	2	0	0	0	0	1	0	0	12	33	**255**
	17 Towson/Luther.	2	4	0	0	1	1	2	-2	2	6	3	6	16	17	11	1	27	1	0	0	-1	-2	0	0	0	0	8	0	**103**
	18 Hunt Val./N Balt	1	1	0	0	1	0	1	-5	-1	7	4	1	14	12	5	0	2	0	1	0	-2	-3	0	0	0	0	6	0	**45**
	19 White Marsh	1	6	0	2	1	0	0	0	7	5	8	20	12	8	6	4	-8	-12	0	0	1	2	0	0	0	0	8	1	**72**
	20 NE Balt Co	-1	0	0	0	1	0	-2	-3	2	6	6	11	13	12	4	1	-4	-13	0	0	1	2	-4	-1	0	0	14	0	**45**
	21 Essex	-13	4	-1	-9	2	1	-26	-86	-8	23	11	32	27	31	15	-7	-16	-53	0	0	-4	4	-3	-1	0	0	21	11	**-45**
	22 Dundalk	-17	-2	-1	-16	2	0	-11	-98	-28	42	-7	101	12	20	6	-42	-23	-54	1	0	4	12	-21	-2	0	0	7	-6	**-121**
	23 BWI/Glen Burnie	1	-1	0	-1	6	1	2	2	1	5	21	1	33	28	9	0	-1	0	0	0	0	-2	1	0	0	0	9	-3	**112**
	24 AA Co	2	-1	0	-1	9	2	4	26	9	8	16	3	41	40	14	0	-1	0	0	0	0	0	5	-4	0	0	24	-38	**158**
	25 Caroll Co	0	0	0	0	1	0	0	2	1	2	1	1	3	3	4	0	0	0	0	0	0	0	0	0	0	0	3	10	**31**
	26 Harford Co	1	1	0	0	3	1	1	-5	8	16	12	39	15	37	5	2	-2	0	1	0	0	1	-3	1	0	-1	20	0	**153**
	27 Howard Co	70	12	3	11	67	22	33	107	47	23	41	8	94	145	68	11	20	3	5	0	4	3	-3	4	0	0	33	-55	**776**
	28 External	7	1	0	0	10	2	7	40	10	16	19	10	41	48	27	10	1	0	1	0	4	3	6	4	0	0	41	0	**308**
	Total	**244**	**80**	**16**	**24**	**294**	**128**	**157**	**522**	**287**	**542**	**364**	**640**	**949**	**1,327**	**660**	**49**	**28**	**-129**	**29**	**3**	**29**	**33**	**69**	**15**	**0**	**-1**	**605**	**29**	**6,993**

Markets	Summary	Percent of Total	Percent Increase from No-Build	Notes
Attractions to the CBD	322	10%	1%	All Region to Districts 8 and 9
Attractions to SSA	862	27%	35%	All Region to Distrcit 14
Attractions to the Bay View Medical Center	420	13%	13%	All Region to District 12
Residents who live and travel in the corridor	1,632	50%	4%	Within Corridor
Total Markets	3,236	46%	3%	
Total Region	6,993			

4.2.2 User Benefits

Based on FTA's definition, user benefits are the changes in mobility for individual travelers that are caused by a project or policy changes, measured in hours of travel time, and summed over all travelers.

Table 15 shows projected daily user benefits for the Low-Cost Alternative over the No-Build Alternative of 7,750 hours. The benefits of the Low-Cost Alternative over the No-Build Alternative can be attributed to the improved service with the proposed at-grade bus route running at 7 and 10 (T1) and 14 (T2) minutes peak/off-peak frequency.

The largest share of user benefit hours (2,073) in the Low-Cost Alternative is from the internal corridor market, residents who live and travel within the corridor. Close to 760 use benefit hours per day would be experienced by trips attracted to the Social Security Administration area, followed by trips attracted to the CBD (463 user benefit hours), and then trips attracted to the Bayview Medical Center (368 user benefit hours).

4.3 Impacts of the Project

While the Low-Cost Alternative offers some benefits over the No-Build Alternative, the LPA attempts to further improve these benefits, particularly for the identified markets. The following sections summarize the impacts of the LPA on transit trips, travel times, travel markets, and daily user benefit hours.

4.3.1 Transit Trips with the LPA

Table 16 shows the projected 2035 daily transit trips by district with the proposed Red Line LRT. Table 17 shows the change in transit trips between the LPA and the Low-Cost Alternative.

When compared to the Low-Cost Alternative, transit trips under the LPA would increase by 13 percent. Of the 117,600 transit trips serving the corridor's markets, 55,100 per day would be attracted to the CBD area from the region. The Social Security Administration and the Bayview Medical Center both attract a similar number of transit trips, 5,000 and 5,200 per day, respectively. Transit trips by residents who live and travel in the corridor represent 44 percent of the corridor's market share, approximately 52,300 transit trips per day.

Compared to the Low-Cost Alternative, the largest increase in transit trips with the LPA would occur in trips to the Social Security Administration and Bayview Medical Center markets, with a 48 and 44 percent increase or approximately 1,600 trips each. The next travel market segment that would see an increase in transit trips over the Low-Cost Alternative is from the residents who live and travel within the corridor, which would increase by 8,270 trips or 19 percent. This is illustrated in Figure 9.

Figure 9 – Increase in Transit Trips by Travel Markets (Red Line LPA minus Low-Cost)

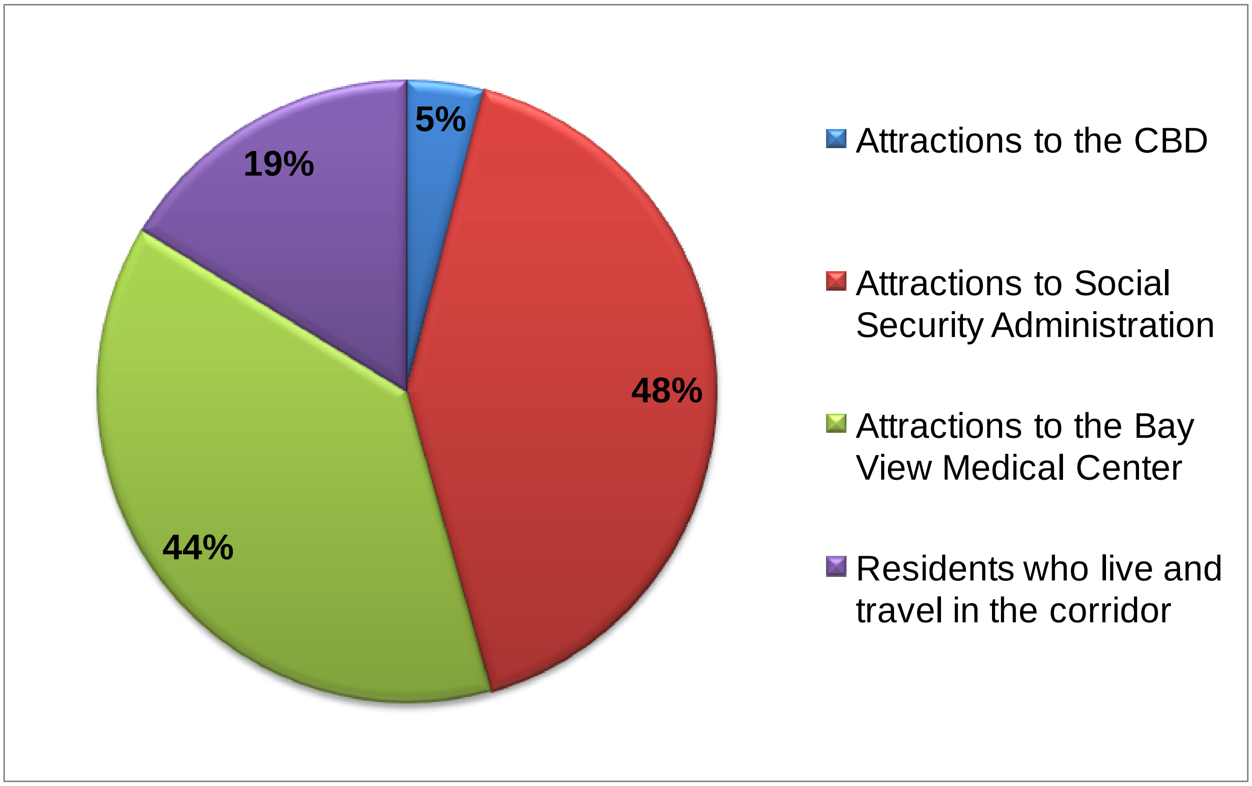


Table 15 – 2035 Daily User Benefits – Low-Cost Alternative versus No-Build Alternative

Productions (rows) / Attractions (columns)

	District	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total
1	NW Balt City	9	7	0	0	30	18	-7	16	57	70	12	41	68	88	75	-2	-2	5	1	0	3	5	18	19	0	0	44	4	579
2	NE Balt City	9	4	1	8	3	1	10	-1	19	8	8	32	16	11	12	9	5	3	4	0	3	-4	0	0	0	0	4	-2	163
3	Waverly	0	1	0	0	1	1	2	-3	2	2	2	5	9	4	7	0	-2	0	0	0	0	0	0	0	0	0	1	0	32
4	Greenmont	2	5	0	0	4	0	3	-6	3	4	2	10	16	14	9	3	-4	0	2	0	-1	-9	0	0	0	0	4	-1	60
5	Edmond. Vill.	34	8	3	15	26	18	26	208	50	23	47	15	40	54	21	10	9	1	2	0	5	5	9	2	0	0	14	9	654
6	Rosemont	17	-1	0	0	20	12	13	126	9	30	25	15	23	40	14	2	-1	-3	0	0	1	2	4	2	0	0	14	45	409
7	Poppleton	15	4	2	1	24	18	59	116	34	70	11	65	46	101	39	6	-3	-4	0	0	3	8	5	2	0	0	69	11	702
8	CBD	-3	-1	0	-2	4	1	2	49	-23	22	-1	7	10	25	6	0	0	0	0	0	0	-1	0	0	0	0	10	26	131
9	East CBD	3	6	0	-5	6	-1	-1	-46	9	20	-1	24	26	39	14	2	-3	-1	2	0	-1	-9	-3	-1	0	0	49	4	132
10	Canton	9	2	0	-1	4	5	6	-5	-8	43	5	44	11	16	7	7	-3	-8	0	0	3	6	-5	-1	0	0	16	27	180
11	S Balt City	4	0	0	-3	23	10	10	-7	2	29	22	14	65	56	18	0	-3	0	1	0	0	-2	8	0	0	0	28	5	280
12	E Balt City	-4	-11	-4	-16	1	1	4	-20	-14	34	-4	52	8	20	7	0	-17	-20	-8	0	-14	-28	-11	-2	0	0	8	6	-32
13	Cantonsville	29	3	1	3	26	11	14	114	22	19	60	12	145	99	36	7	8	2	2	0	3	3	28	3	0	0	37	-11	676
14	SSA/Sec. Sqr.	50	8	2	10	19	12	33	234	51	15	47	15	80	202	65	12	25	8	1	0	5	5	26	5	0	0	24	11	965
15	Randallstown	69	10	4	12	25	13	34	147	48	24	24	18	55	139	133	22	18	12	2	0	5	3	11	3	0	0	26	37	894
16	Owings Mills	1	4	0	0	5	1	2	11	17	33	4	54	18	23	24	0	-2	0	2	0	0	1	0	1	0	0	8	47	254
17	Towson/Luther.	1	3	0	0	1	0	2	-1	2	6	4	6	15	16	10	1	27	0	0	0	-1	-1	0	0	0	0	5	-1	95
18	Hunt Val./N Balt	1	0	0	0	1	0	1	-5	0	7	3	1	13	11	4	0	4	1	0	0	-2	-3	0	0	0	0	4	0	41
19	White Marsh	1	5	0	2	1	0	1	-1	6	3	7	13	11	6	5	3	-1	-8	1	0	0	1	0	0	0	0	5	2	63
20	NE Balt Co	0	0	0	0	0	0	-1	-3	1	4	4	6	9	8	3	2	-1	-7	1	0	1	1	-3	0	0	0	10	0	35
21	Essex	-2	4	0	-8	1	1	-15	-77	-10	22	15	25	28	28	11	-1	-10	-34	-1	0	-1	0	-2	-1	0	0	15	10	-2
22	Dundalk	-11	-2	-1	-14	2	0	-7	-103	-29	34	-3	81	12	20	5	-28	-17	-36	1	0	0	3	-15	-2	0	0	5	-4	-109
23	BWI/Glen Burnie	0	-1	0	0	4	1	3	1	1	6	22	2	42	29	10	0	0	0	0	0	0	-1	4	0	0	0	7	-4	126
24	AA Co	2	0	0	0	6	2	4	18	7	7	17	3	39	34	13	1	0	0	0	0	0	-1	8	4	0	0	13	-22	155
25	Caroll Co	0	0	0	0	0	0	0	2	1	1	1	1	2	10	3	-2	0	0	0	0	0	0	0	1	0	0	1	10	31
26	Harford Co	1	4	0	1	2	1	1	-4	7	12	12	24	13	23	3	2	-1	0	1	0	1	0	-2	0	0	3	16	0	120
27	Howard Co	35	9	2	7	32	11	21	115	35	15	30	6	56	70	29	8	13	2	5	1	5	3	12	24	0	0	122	49	717
28	External	12	1	0	0	15	3	9	47	12	20	21	14	54	71	36	21	0	1	3	0	9	6	8	5	0	0	32	0	400
Total		284	72	10	10	286	140	229	922	311	583	396	605	930	1,257	619	85	39	-86	22	1	27	-7	100	64	0	3	591	258	7,751

Markets	Summary	Percent of Total	Notes
Attractions to the CBD	463	13%	All Region to Districts 8 and 9
Attractions to SSA	760	21%	All Region to Distrcit 14
Attractions to the Bay View Medical Center	368	10%	All Region to District 12
Residents who live and travel in the corridor	2,073	57%	Within Corridor
Total Markets	3,664	47%	
Total Region	7,751		

Table 16 – 2035 Red Line LRT LPA Alternative Transit Trips by District

	District		Attractions																												Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
Productions	1	NW Balt City	5,396	587	267	1,119	255	332	2,147	9,261	2,743	686	924	524	440	899	664	1,251	1,299	1,014	97	15	231	152	434	76	0	0	281	1,280	**32,374**
	2	NE Balt City	753	1,417	240	561	39	60	595	3,451	871	183	285	356	115	212	82	343	860	254	380	26	232	187	145	31	0	0	56	456	**12,190**
	3	Waverly	471	322	414	383	19	82	277	1,692	324	41	132	110	71	70	61	207	401	135	62	7	47	45	83	9	0	0	25	330	**5,820**
	4	Greenmont	895	517	246	1,520	53	70	386	2,661	1,010	165	264	241	140	145	71	282	541	280	125	11	108	133	116	21	0	0	68	293	**10,362**
	5	Edmond. Vill.	312	50	29	152	313	150	293	1,605	388	155	375	126	214	328	91	107	92	80	11	2	31	37	144	23	0	0	97	301	**5,506**
	6	Rosemont	629	93	37	115	176	364	537	1,781	342	163	353	121	178	218	81	107	123	70	15	2	28	45	154	32	0	0	91	218	**6,073**
	7	Poppleton	2,175	522	157	714	327	555	3,382	6,872	1,574	649	1,134	539	428	584	241	474	593	382	51	7	118	181	584	107	0	0	375	510	**23,235**
	8	CBD	826	123	26	199	101	78	983	4,732	1,147	589	389	326	172	292	123	208	254	291	27	2	37	45	493	50	0	0	181	844	**12,538**
	9	East CBD	1,057	565	124	745	90	138	809	4,394	2,628	815	595	451	217	236	100	300	432	275	125	9	142	235	224	56	0	0	247	324	**15,333**
	10	Canton	486	174	32	210	67	57	426	2,577	921	1,108	258	591	107	154	68	254	162	187	73	7	112	222	212	39	0	0	156	375	**9,035**
	11	S Balt City	539	115	43	235	243	151	641	2,956	526	301	1,551	254	520	281	114	167	172	126	33	3	41	87	861	114	0	0	274	330	**10,678**
	12	E Balt City	243	203	36	156	36	36	239	986	343	458	216	1,112	86	125	50	187	149	121	96	7	137	591	168	25	0	0	88	66	**5,960**
	13	Cantonsville	351	55	18	86	200	130	268	1,859	302	140	689	118	1,022	483	155	155	181	132	29	3	48	41	413	76	0	0	271	678	**7,903**
	14	SSA/Sec. Sqr.	405	33	15	74	161	82	345	1,576	405	180	256	172	292	811	212	105	124	110	12	2	37	25	173	17	0	0	150	346	**6,120**
	15	Randallstown	1,284	116	73	231	133	123	622	3,519	927	179	325	206	235	604	777	389	260	210	29	7	132	57	206	33	0	0	215	998	**11,890**
	16	Owings Mills	952	164	32	289	49	51	462	3,177	929	340	260	832	129	181	214	1,043	410	305	147	10	233	156	201	35	0	0	57	480	**11,138**
	17	Towson/Luther.	733	432	118	293	23	34	281	2,556	521	122	191	168	110	185	80	398	3,056	580	156	10	164	48	164	24	0	0	64	590	**11,101**
	18	Hunt Val./N Balt	361	50	10	101	31	25	320	1,557	305	188	152	245	103	160	59	166	328	698	34	3	49	34	262	33	0	0	63	264	**5,601**
	19	White Marsh	182	359	36	144	11	17	130	814	238	79	131	180	72	121	36	203	386	151	295	14	163	67	110	15	0	0	36	386	**4,376**
	20	NE Balt Co	128	61	7	46	11	10	75	642	104	56	92	82	72	151	35	219	104	216	27	5	26	15	135	23	0	4	64	277	**2,687**
	21	Essex	387	243	23	157	21	26	218	1,589	343	162	199	281	158	326	124	799	381	305	228	11	544	192	176	24	0	0	91	455	**7,463**
	22	Dundalk	192	167	30	170	19	35	130	1,323	378	303	276	992	125	166	69	350	157	119	96	5	178	752	197	23	0	0	64	270	**6,586**
	23	BWI/Glen Burnie	243	30	8	47	72	45	303	1,344	231	183	509	136	196	173	73	78	96	145	7	1	13	15	1,082	273	0	0	78	415	**5,796**
	24	AA Co	140	18	6	48	38	29	147	1,263	154	83	311	72	181	138	54	67	77	105	10	0	13	10	909	1,694	0	0	174	6,167	**11,908**
	25	Caroll Co	45	3	1	11	3	1	22	228	35	14	24	14	13	30	27	42	14	14	2	0	13	2	39	8	0	0	19	90	**714**
	26	Harford Co	157	21	9	77	20	16	89	1,210	244	134	201	252	94	214	24	271	98	91	13	0	11	19	201	23	0	1,255	73	371	**5,188**
	27	Howard Co	249	27	13	79	105	53	155	1,913	293	78	191	84	147	246	91	57	98	99	15	1	20	19	160	78	0	0	3,272	4,673	**12,216**
	28	External	243	33	23	115	38	40	123	1,395	230	96	184	71	145	175	75	78	80	110	13	2	31	18	257	219	0	0	652	0	**4,446**
		Total	**19,834**	**6,500**	**2,073**	**8,077**	**2,654**	**2,790**	**14,405**	**68,933**	**18,456**	**7,650**	**10,467**	**8,656**	**5,782**	**7,708**	**3,851**	**8,307**	**10,928**	**6,605**	**2,208**	**172**	**2,939**	**3,430**	**8,303**	**3,181**	**0**	**1,259**	**7,282**	**21,787**	**264,237**

Markets	Summary	Percent of Total	Notes
Attractions to the CBD	55,118	47%	All Region to Districts 8 and 9
Attractions to SSA	4,960	4%	All Region to Distrcit 14
Attractions to the Bay View Medical Center	5,218	4%	All Region to District 12
Residents who live and travel in the corridor	52,319	44%	Within Corridor
Total Markets	117,615	45%	
Total Region	264,237		

Table 17 – Difference in Transit Trips (2035 LPA minus Low-Cost Alternative)

Productions (rows) / Attractions (columns)

	District	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total
1	NW Balt City	1	-2	0	-1	45	13	131	51	44	207	9	184	6	199	14	14	-6	-30	0	0	26	15	-10	0	0	0	-2	41	**949**
2	NE Balt City	-5	0	-1	-1	6	3	1	33	-4	15	8	53	10	65	5	-3	-7	0	0	0	10	13	1	1	0	0	8	-4	**207**
3	Waverly	0	0	0	0	2	1	0	3	1	3	1	11	5	19	3	0	0	0	0	0	3	2	0	0	0	0	3	0	**57**
4	Greenmont	-3	5	0	-2	5	1	0	5	-2	10	4	28	11	45	4	-2	0	-1	0	0	7	7	-1	0	0	0	11	-3	**129**
5	Edmond. Vill.	62	3	3	16	4	6	71	282	77	68	29	64	11	104	21	17	6	22	3	1	9	9	29	3	0	0	15	33	**968**
6	Rosemont	6	0	0	0	6	-2	14	68	18	33	11	33	12	52	9	1	0	3	2	1	5	8	8	1	0	0	20	-4	**305**
7	Poppleton	99	1	-1	0	41	11	115	404	105	215	31	169	15	163	29	30	6	27	1	1	8	13	45	1	0	0	27	7	**1,563**
8	CBD	-13	0	0	-1	64	23	299	127	24	397	3	268	-31	210	4	20	-14	-69	0	0	0	0	-36	0	0	0	25	16	**1,316**
9	East CBD	11	1	0	1	24	10	109	80	6	139	8	106	-2	86	5	10	-2	-14	1	0	-4	0	-6	1	0	0	8	9	**587**
10	Canton	163	5	1	14	35	19	213	743	150	178	68	166	33	105	31	63	23	69	4	1	5	12	90	9	0	0	61	40	**2,301**
11	S Balt City	8	2	0	4	17	7	40	49	15	70	17	81	13	81	11	4	0	-3	1	0	5	10	3	-1	0	0	17	-10	**441**
12	E Balt City	105	18	2	15	23	12	147	416	105	145	48	104	22	74	23	41	21	47	8	1	7	15	64	5	0	0	24	1	**1,493**
13	Cantonsville	4	2	0	4	12	11	16	60	9	40	24	47	13	53	1	5	4	-4	4	0	11	7	-8	2	0	0	-22	6	**301**
14	SSA/Sec. Sqr.	144	6	3	22	47	22	190	692	191	145	81	129	21	124	27	35	28	64	4	1	18	10	86	3	0	0	16	12	**2,121**
15	Randallstown	10	1	0	1	24	11	40	74	31	64	21	82	2	56	3	4	0	-4	1	0	29	11	7	2	0	0	-4	43	**509**
16	Owings Mills	18	-1	0	0	12	4	51	50	38	122	3	296	2	49	6	0	0	-1	-1	0	39	29	5	1	0	0	-7	75	**790**
17	Towson/Luther.	-7	-1	0	0	5	1	16	-9	5	35	0	44	1	55	3	0	-1	-19	0	0	6	2	-5	0	0	0	-3	0	**128**
18	Hunt Val./N Balt	-34	-1	0	-1	17	6	65	-80	-5	119	-5	135	-14	99	0	1	-20	-84	-1	0	8	6	-24	0	0	0	-5	0	**182**
19	White Marsh	5	-1	0	0	3	4	7	71	14	18	9	44	10	65	6	8	0	1	1	0	-1	6	1	0	0	0	-2	-4	**265**
20	NE Balt Co	11	3	0	1	5	4	11	89	20	27	12	39	14	105	11	20	0	2	1	0	3	4	5	1	0	0	-4	1	**385**
21	Essex	69	8	1	20	8	7	52	340	49	39	26	61	31	199	45	166	3	23	-7	0	-25	14	18	2	0	0	17	-14	**1,152**
22	Dundalk	53	16	2	32	6	12	35	361	70	62	78	135	38	97	28	139	25	44	11	0	12	23	46	5	0	0	25	17	**1,372**
23	BWI/Glen Burnie	-11	1	0	0	22	9	83	-26	-5	126	-1	98	-21	96	3	5	-5	-27	0	0	1	2	-25	1	0	0	-6	6	**326**
24	AA Co	2	0	0	0	0	1	2	38	14	28	-3	36	-4	57	2	1	0	0	0	0	1	1	1	1	0	0	-10	-2	**166**
25	Caroll Co	0	0	0	0	0	0	1	0	2	6	0	7	0	11	0	0	0	0	0	0	2	1	1	1	0	0	-1	44	**75**
26	Harford Co	20	-1	0	-1	5	2	6	175	25	70	-1	130	7	119	5	45	0	0	0	0	2	7	7	0	0	0	-7	-2	**613**
27	Howard Co	10	-2	0	10	-8	-1	12	384	61	22	8	47	-9	52	-1	1	2	12	0	0	5	7	6	-2	0	0	-17	-27	**572**
28	External	42	-1	-1	-1	0	2	4	338	55	34	-10	33	-3	83	4	11	-1	0	0	0	1	1	3	0	0	0	-31	0	**563**
	Total	**770**	**62**	**9**	**132**	**430**	**199**	**1,731**	**4,818**	**1,113**	**2,437**	**479**	**2,630**	**193**	**2,523**	**302**	**636**	**62**	**58**	**33**	**6**	**193**	**235**	**311**	**37**	**0**	**0**	**156**	**281**	**19,836**

Markets	Summary	Percent of Total	Percent Increase from Low Cost	Notes
Attractions to the CBD	2,443	18%	5%	All Region to Districts 8 and 9
Attractions to SSA	1,605	12%	48%	All Region to Distrcit 14
Attractions to the Bay View Medical Center	1,591	11%	44%	All Region to District 12
Residents who live and travel in the corridor	8,268	59%	19%	Within Corridor
Total Markets	13,907	70%	13%	
Total Region	19,836			

4.3.2 Travel Time Savings

The purpose of the proposed Red Line Corridor LRT is to improve transit travel times and, therefore, provide improved service to serve each of the four key markets.

As shown in Figure 10, during the peak period, riders would save approximately 20 minutes of in-vehicle travel time on average with the LPA. A trip from the Social Security Administration to the CBD would save 20 minutes (50 minutes in the Low-Cost Alternative compared with 30 minutes on Light Rail), and a trip from Downtown Baltimore to the Bayview Medical Center is estimated to take close to 50 minutes on the proposed bus route for the Low-Cost Alternative (Route T1) compared to approximately 27 minutes with the proposed LPA. The largest savings in-vehicle travel times would come from riders traveling from the entire length of the corridor from Bayview Medical Center to the Social Security Administration area. During the peak period, riders would save close to 36 minutes with the Red Line LRT when compared to the bus service in the Low-Cost Alternative.

Figure 10 – Comparison of 2035 Travel Times by Markets between the Low-Cost Alternative and the LPA

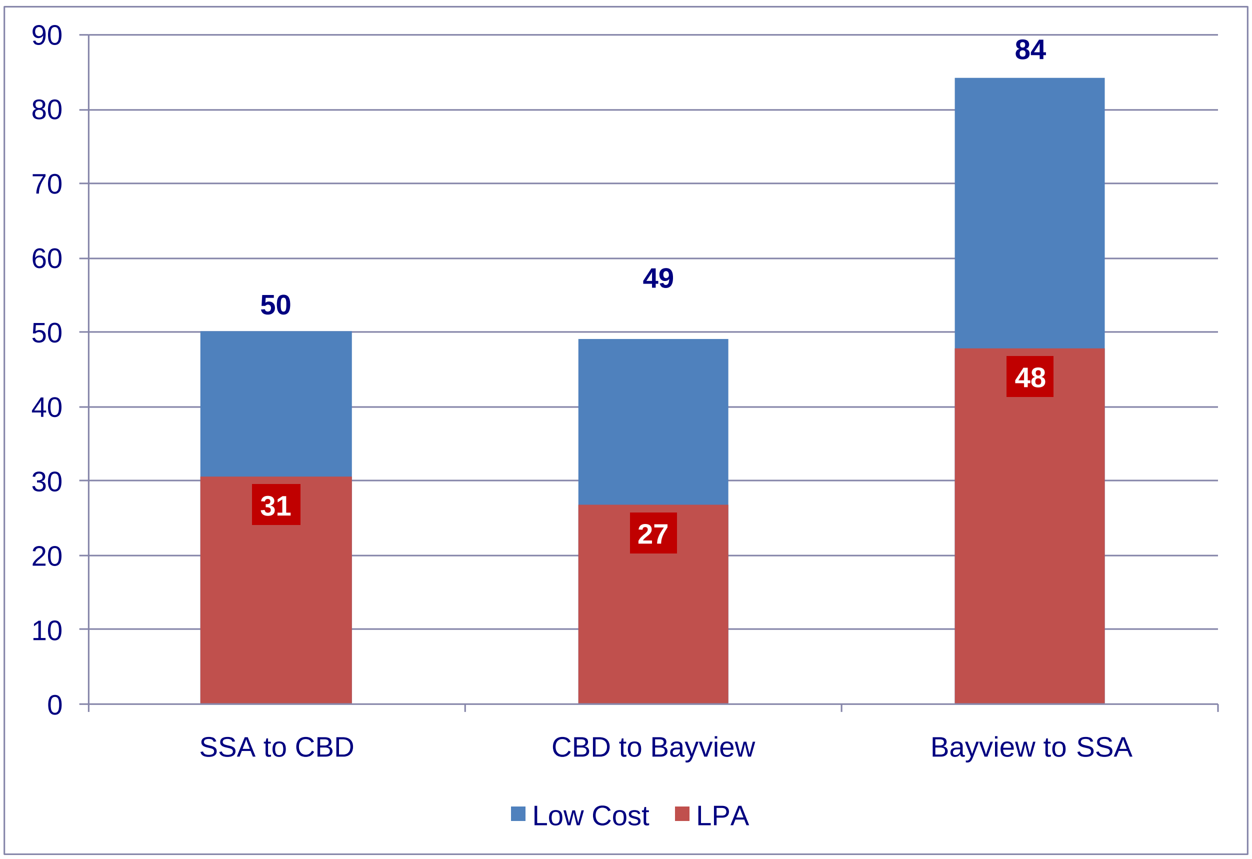


Table 18 summarizes the travel time savings impacts of the LPA when compared to the Low-Cost Alternative. A vast majority of the travel time savings come from the In-Vehicle Time (IVT) where, for example, the LPA saves between 12 (CBD to Social Security Administration area) and 30 minutes for the entire length of the corridor (Bayview Medical Center to Social Security Administration area) during the peak period.

In most instances, the wait time between the LPA and Low Cost is identical (light rail compared with the combined headway of the T1 and T2 routes). This is the case except at both ends of the corridor (west of the I-70 Park-and-Ride lot and east of Fells Point), where the alignments are slightly different. For the example trip interchanges displayed in the table, the specific zones selected are in locations where the T1 and T2 route alignment differ to improve coverage. For walk access time and out-of-vehicle time (which includes egress and transfer walk time), the values are identical or very comparable.

Table 18 - Travel Time Savings

Market	Origin Location	Destination Location	Alternative	Transit Path	IVT (min)	Wait Time (min)	Walk Access Time (min)	OVT (min)	No of Transfers	Total Travel Time (IVT + 2 OVT) (min)
Attractions to CBD	SSA (District 14)	CBD (District 8)	Low Cost	T1	39	4	2	6	0	50
			LPA	Red Line	19	4	2	6	0	31
Attractions to SSA	CBD (District 8)	SSA (District 14)	Low Cost	T1	33	7	2	9	0	51
			LPA	Red Line	21	4	2	6	0	32
	Essex County (District 21)	SSA (District 14)	Low Cost	MTA23, T1	72	17	2	19	1	110
			LPA	Red Line	60	11	2	13	1	87
Attractions to Bayview Medical Center	CBD (District 8)	Bayview Medical Center (District 12)	Low Cost	T1	31	7	2	9	0	49
			LPA	Red Line	16	4	2	6	0	27
Residents within the Corridor	Bayview Medical Center (District 12)	SSA (District 14)	Low Cost	T1	66	7	2	9	0	84
			LPA	Red Line	36	4	2	6	0	48

4.3.3 New Transit Trips

The proposed LRT would generate approximately 18,820 new transit trips daily. Approximately 7,600 of these trips were generated by applying the Non-Home Based Direct Demand (NHB DD) Model.[1] The figures shown in Table 19 and the subsequent analysis do not include trips from the NHB DD Model.

Over 60 percent (7,020) of the new daily transit trips (11,240) are within the identified markets for the corridor. Approximately 2,340 of the new transit trips are attracted to the CBD, 1,320 to the Social Security Administration, and 1,230 to the Bayview Medical Center. The remaining new transit trips (2,130) are generated and produced by residents living and traveling in the corridor.

[1] "Baltimore Red Line Corridor Transit Study Travel Model: Calibration and Validation Report," June 7, 2010.

Table 19 – New Transit Trips with the LPA

	District	Attractions 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total
Productions 1	NW Balt City	1	-2	0	0	21	3	6	30	34	69	5	87	16	126	9	0	0	0	1	0	27	15	1	1	0	0	-1	41	490
2	NE Balt City	-6	0	-1	-2	6	2	0	32	-6	13	8	51	10	64	4	-3	-7	-1	0	0	11	13	1	0	0	0	10	-4	195
3	Waverly	0	-1	0	0	1	0	0	3	0	3	1	10	4	18	3	0	0	0	0	0	3	2	0	0	0	0	4	0	51
4	Greenmont	-3	4	0	-2	4	1	-1	5	-1	8	4	28	10	45	4	-2	0	0	0	0	7	7	0	0	0	0	13	-2	129
5	Edmond. Vill.	31	3	2	15	-2	2	23	152	49	29	20	36	8	73	16	9	4	10	3	1	9	9	12	2	0	0	15	33	564
6	Rosemont	-3	1	0	0	3	-1	3	31	11	25	8	26	11	47	7	-1	-1	-1	2	0	6	7	5	0	0	0	20	-4	202
7	Poppleton	1	1	0	0	11	0	1	47	17	56	6	56	10	78	7	0	-1	-1	1	0	8	13	3	1	0	0	27	7	349
8	CBD	1	0	0	0	0	-2	1	-5	10	22	-2	0	2	11	-1	0	0	0	0	0	1	1	0	0	0	0	26	16	81
9	East CBD	4	2	0	2	5	3	5	20	6	13	6	16	6	22	1	0	0	1	0	0	-5	0	1	1	0	0	11	9	129
10	Canton	50	5	1	12	11	10	38	273	37	82	35	51	19	30	8	37	11	24	4	0	4	13	25	8	0	0	59	40	887
11	S Balt City	4	2	0	4	10	5	7	27	11	30	16	53	17	58	9	1	1	1	1	0	5	11	3	0	0	0	17	-10	283
12	E Balt City	16	17	2	13	2	5	8	46	14	17	23	55	10	14	5	19	10	12	8	0	8	15	13	4	0	0	27	1	364
13	Cantonsville	12	2	0	5	8	9	9	94	18	22	26	33	18	41	3	5	5	7	5	1	11	8	6	2	0	0	-21	6	335
14	SSA/Sec. Sqr.	40	5	2	21	13	11	37	276	92	20	51	41	7	48	2	10	17	22	5	1	18	10	29	3	0	0	17	12	810
15	Randallstown	10	0	0	4	20	9	11	86	34	32	21	60	5	34	3	0	2	1	1	0	28	11	9	2	0	0	-4	48	427
16	Owings Mills	0	-1	0	0	4	1	2	1	24	80	0	265	3	26	0	0	0	0	-1	0	37	28	2	1	0	0	-6	76	542
17	Towson/Luther.	-1	-1	0	0	2	0	0	5	7	12	1	27	3	42	3	-1	-1	0	0	0	6	3	0	0	0	0	-1	0	106
18	Hunt Val./N Balt	0	0	0	0	2	0	-1	1	11	27	0	69	1	49	4	0	0	0	0	0	7	6	0	0	0	0	-5	0	171
19	White Marsh	4	0	0	0	3	3	6	68	13	18	8	44	10	66	6	8	0	1	0	0	0	6	1	0	0	0	0	-4	261
20	NE Balt Co	10	2	0	1	4	3	10	90	19	24	9	39	11	99	9	17	1	2	0	0	2	4	5	1	0	0	-7	6	361
21	Essex	64	8	1	17	8	7	40	277	44	36	20	61	29	198	45	164	4	22	-5	0	-18	16	18	3	0	0	17	-3	1,073
22	Dundalk	52	15	3	29	6	11	30	301	65	59	72	135	38	97	28	139	24	44	10	0	14	29	46	5	0	0	26	17	1,295
23	BWI/Glen Burnie	0	0	0	0	3	1	0	-1	3	11	0	16	0	34	3	0	0	0	0	0	1	2	0	1	0	0	-5	6	75
24	AA Co	3	0	0	0	1	1	1	46	15	27	-1	36	-3	55	3	1	0	0	0	0	1	2	1	2	0	0	-10	40	221
25	Caroll Co	0	0	0	0	0	0	0	0	2	6	0	7	0	10	0	5	0	0	0	0	2	0	1	1	0	0	-1	44	77
26	Harford Co	20	-1	0	0	5	2	6	176	25	69	-1	130	7	119	6	45	0	0	0	0	2	6	6	0	0	0	-7	-2	613
27	Howard Co	15	0	1	7	-3	3	10	324	57	26	7	48	-5	56	3	3	3	12	1	0	8	9	7	1	0	0	-5	-13	575
28	External	42	-1	0	-1	0	2	5	343	57	34	-8	34	-3	82	4	10	0	0	0	0	0	1	2	-1	0	0	-31	0	571
Total		**367**	**60**	**11**	**125**	**148**	**91**	**257**	**2,748**	**668**	**870**	**335**	**1,514**	**244**	**1,642**	**194**	**466**	**72**	**156**	**36**	**3**	**203**	**247**	**197**	**38**	**0**	**0**	**185**	**360**	**11,237**

Markets	Summary	Percent of Total	Notes
Attractions to the CBD	2,340	33%	All Region to Districts 8 and 9
Attractions to SSA	1,319	19%	All Region to Distrcit 14
Attractions to the Bay View Medical Center	1,233	18%	All Region to District 12
Residents who live and travel in the corridor	2,131	30%	Within Corridor
Total Markets	7,023	62%	
Total Region	11,237		

4.3.4 User Benefits

Mobility Improvements also known as Transportation Systems User Benefits (user benefits) is one of the several criteria used by FTA to evaluate a New Starts project. Using the definition provided in Section 4.2.2 and based on the concept of consumer surplus, user benefits are estimated based on the results of the travel forecasting models. User benefits are calculated for the LPA over the Low-Cost Alternative and the Low-Cost Alternative over the No-Build Alternative. User benefits are measured in hours of travel time and aggregated over all travelers.

Table 20 shows the distribution of daily user benefit hours by district when the proposed Red Line LRT is in place. When compared to the Low-Cost Alternative, the total user benefits with the LPA is 17,688 daily hours, including 5,843 hours from the NHB DD model. Thirty percent of the hours (excluding the NHB DD hours) are user benefits experienced by residents living and traveling in the corridor. Approximately 2,100 hours or 18 percent of the user benefit hours are experienced by trips attracted to the CBD. Trips attracted to the Social Security Administration area and the Bayview Medical Center will experience approximately 1,000 hours of user benefits per day.

The four key markets account for approximately 65 percent of the total user benefits (excluding consideration of NHB Direct Demand benefits). However, when benefits for other travelers who have at least one end of their trip within the corridor are considered, then over 87 percent of the benefits are associated with the project.

Table 20 – Daily User Benefit Hours with the LPA

		District	Attractions 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total
Productions	1	NW Balt City	1	-2	0	0	22	3	7	40	48	88	5	100	17	129	8	0	0	0	1	0	22	17	1	0	0	0	-2	77	**582**
	2	NE Balt City	-5	2	-1	-2	5	2	-3	21	-7	12	7	46	9	57	4	-4	-6	-1	1	0	6	12	0	0	0	0	7	-9	**153**
	3	Waverly	0	-1	0	0	1	0	0	3	0	3	1	8	4	17	3	0	0	0	0	0	2	2	0	0	0	0	3	0	**46**
	4	Greenmont	-2	4	0	-2	6	1	-1	7	-1	10	3	32	13	51	5	-3	0	0	0	0	6	8	0	0	0	0	12	-4	**145**
	5	Edmond. Vill.	33	4	2	14	-3	3	35	272	61	39	21	39	8	77	17	10	4	9	2	1	9	10	13	1	0	0	11	53	**745**
	6	Rosemont	-5	1	0	0	4	-1	0	50	11	33	8	33	12	56	9	-3	-3	-2	2	0	6	10	5	1	0	0	17	-12	**232**
	7	Poppleton	2	3	-2	-1	22	1	0	138	35	120	8	134	15	173	15	1	-5	-3	1	1	14	24	5	1	0	0	31	65	**798**
	8	CBD	2	0	0	0	2	-1	2	12	17	31	0	5	3	20	2	0	0	0	0	0	1	1	1	0	0	0	25	40	**163**
	9	East CBD	11	-1	-1	1	9	8	21	94	11	28	18	44	12	66	5	3	1	1	1	0	-6	5	5	2	0	0	26	58	**422**
	10	Canton	57	5	1	12	12	11	53	471	43	93	34	56	19	34	10	41	12	28	4	0	3	13	27	6	0	0	38	90	**1,173**
	11	S Balt City	3	2	0	4	12	5	8	38	12	42	15	61	17	74	11	1	1	1	1	0	5	15	2	0	0	0	9	-19	**320**
	12	E Balt City	39	29	5	33	6	10	24	172	38	33	58	89	28	36	12	49	30	29	16	1	12	20	34	7	0	0	38	4	**852**
	13	Cantonsville	12	2	0	4	11	11	10	122	19	26	27	35	16	39	3	4	4	5	3	1	9	9	4	1	0	0	-18	0	**359**
	14	SSA/Sec. Sqr.	41	6	3	19	18	14	47	376	91	20	52	33	8	45	2	8	16	17	3	1	12	9	24	3	0	0	11	24	**903**
	15	Randallstown	11	0	0	4	21	9	11	136	34	34	21	56	4	23	2	0	3	1	1	0	17	10	9	2	0	0	-3	52	**458**
	16	Owings Mills	0	-1	0	0	4	1	2	1	25	75	0	268	2	22	0	0	0	0	-1	0	22	24	2	1	0	0	-4	109	**552**
	17	Towson/Luther.	-1	-1	0	0	2	0	0	0	6	11	1	24	3	34	2	-1	-1	0	0	0	4	2	0	0	0	0	-1	0	**84**
	18	Hunt Val./N Balt	0	0	0	0	1	0	-1	-1	10	24	0	57	1	37	3	0	0	0	0	0	5	5	0	0	0	0	-4	0	**137**
	19	White Marsh	3	0	0	0	2	2	5	59	10	13	6	32	8	43	5	6	0	1	0	0	-2	5	1	0	0	0	0	-17	**182**
	20	NE Balt Co	5	2	0	0	4	2	7	76	13	16	7	23	8	45	5	6	0	1	0	0	2	3	2	1	0	0	-5	5	**228**
	21	Essex	46	12	1	17	7	7	31	221	42	32	20	52	29	124	28	105	4	15	0	0	-11	19	13	2	0	0	12	-16	**812**
	22	Dundalk	40	17	3	24	7	10	26	305	58	48	59	100	35	67	22	85	21	28	9	0	11	29	34	4	0	0	16	25	**1,083**
	23	BWI/Glen Burnie	0	1	0	0	4	3	0	-2	3	12	0	15	-1	32	4	0	0	0	0	0	1	2	0	1	0	0	-4	9	**80**
	24	AA Co	1	0	0	0	1	1	0	38	11	21	-1	24	-3	40	3	1	0	0	0	0	1	1	1	1	0	0	-7	13	**147**
	25	Caroll Co	0	0	0	0	0	0	0	0	2	5	0	5	0	7	1	6	0	0	0	0	-1	0	1	0	0	0	-1	35	**60**
	26	Harford Co	10	-1	0	0	4	2	5	158	19	50	-1	94	7	86	5	22	0	0	0	0	1	5	3	0	0	0	-5	-13	**451**
	27	Howard Co	6	-1	0	3	-5	0	3	212	33	15	3	24	-6	35	2	1	0	8	0	0	2	6	4	1	0	0	-3	-46	**297**
	28	External	17	0	0	-1	-2	0	2	288	32	19	-10	16	-3	37	8	4	-1	-1	0	0	-2	2	1	-1	0	0	-24	0	**381**
	Total		**327**	**82**	**11**	**129**	**177**	**104**	**294**	**3,307**	**676**	**953**	**362**	**1,505**	**265**	**1,506**	**196**	**342**	**80**	**137**	**44**	**5**	**151**	**268**	**192**	**34**	**0**	**0**	**175**	**523**	**11,845**

Markets	Summary	Percent of Total	Notes
Attractions to the CBD	2,091	27%	All Region to Districts 8 and 9
Attractions to SSA	999	13%	All Region to Distrcit 14
Attractions to the Bay View Medical Center	1,072	14%	All Region to District 12
Residents who live and travel in the corridor	3,526	46%	Within Corridor
Total Markets	7,688	65%	
Total Region	11,845		

4.3.5 Trips Using the Red Line LRT

Project trips are defined as trips using any part of the project, getting on and off at the stations along the proposed Red Line LRT. The district-to-district project trip distribution is shown in Table 21.

The Red Line LRT generates approximately 54,520 project trips, with 60 percent of the trips serving the markets identified using the corridor. Approximately 9,410 daily project trips are attracted to the CBD from the region. Number of project trips attracted to the Social Security Administration area and the Bayview Medical Center is similar, approximately 3,200 trips per day. The largest number of project trips, 16,640, is in the travel market from residents who live and travel within the corridor.

4.3.6 User Benefits per Project Trips

The summary in Table 22 shows that on average user benefits per project trip is 13 minutes over the entire region. Trips attracted to the CBD will have on average 12 minutes of benefits per project trip. Trips attracted to the Social Security Administration and the Bayview Medical Center will experience the highest number of minutes of user benefits per project trips, at 18 and 22 minutes, respectively. On average residents who live and travel within the corridor will experience 14 minutes of user benefits per project trip.

Table 21 – Daily Project Trips with the LPA

Productions	District	Attractions																												Total
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	
1	**NW Balt City**	5	6	0	8	163	46	47	506	254	532	56	442	84	430	28	1	2	4	2	0	91	122	20	7	0	0	68	175	**3,101**
2	**NE Balt City**	26	0	0	1	31	19	36	261	66	49	41	63	38	154	22	29	3	8	1	0	1	14	5	1	0	0	17	16	**902**
3	**Waverly**	1	0	0	0	14	18	2	19	22	14	6	21	22	47	12	1	0	0	0	0	0	4	0	0	0	0	7	0	**210**
4	**Greenmont**	8	0	0	1	37	17	12	118	50	40	21	79	48	126	20	5	0	0	1	0	7	20	0	0	0	0	22	9	**641**
5	**Edmond. Vill.**	221	35	21	112	5	14	228	1,330	326	144	143	123	27	241	74	105	69	68	9	2	29	35	101	16	0	0	60	157	**3,694**
6	**Rosemont**	56	12	2	10	11	5	79	707	115	125	73	104	16	157	37	26	12	16	5	1	21	38	69	12	0	0	52	19	**1,778**
7	**Poppleton**	74	24	1	20	170	60	179	768	191	507	76	480	86	494	62	39	10	11	4	1	66	156	41	8	0	0	143	111	**3,780**
8	**CBD**	15	2	0	1	69	26	28	278	68	470	10	296	23	278	13	5	0	0	0	0	12	28	3	1	0	0	48	232	**1,908**
9	**East CBD**	29	5	1	5	56	41	30	146	88	119	52	210	61	226	23	11	4	4	3	0	9	66	4	3	0	0	92	130	**1,415**
10	**Canton**	324	15	5	40	60	42	333	1,642	152	332	171	257	82	152	60	194	57	137	11	1	11	37	160	25	0	0	107	227	**4,634**
11	**S Balt City**	40	10	2	20	66	30	77	367	91	219	93	226	49	219	40	20	15	10	4	0	22	78	26	5	0	0	64	37	**1,830**
12	**E Balt City**	216	39	14	75	35	32	224	863	163	228	200	134	82	125	49	182	98	117	22	2	9	12	162	23	0	0	80	38	**3,223**
13	**Cantonsville**	72	12	4	23	28	29	68	656	115	113	90	111	17	138	16	61	53	41	12	1	34	38	49	10	0	0	7	89	**1,888**
14	**SSA/Sec. Sqr.**	215	23	10	65	89	49	318	1,513	394	178	194	172	68	165	7	86	92	109	10	2	36	24	146	11	0	0	46	105	**4,129**
15	**Randallstown**	19	13	4	43	107	52	60	955	195	170	96	198	31	100	4	2	24	62	4	1	84	57	46	9	0	0	15	236	**2,585**
16	**Owings Mills**	0	14	0	7	47	19	16	45	105	324	10	791	41	140	1	0	0	0	0	0	123	157	4	5	0	0	13	288	**2,148**
17	**Towson/Luther.**	1	1	0	0	17	7	3	77	41	76	9	98	28	128	14	0	0	0	0	0	10	18	0	0	0	0	16	0	**544**
18	**Hunt Val./N Balt**	1	2	0	0	22	6	1	16	34	180	4	232	20	159	15	1	0	0	0	0	25	34	0	0	0	0	14	0	**767**
19	**White Marsh**	19	2	0	5	10	9	19	217	44	39	26	71	28	115	17	42	1	2	1	0	1	8	5	0	0	0	13	14	**706**
20	**NE Balt Co**	26	3	0	5	10	7	20	229	42	47	23	65	28	150	20	48	2	4	0	0	3	9	12	3	0	0	24	71	**853**
21	**Essex**	240	7	1	26	20	22	123	803	115	77	113	65	108	327	105	562	48	158	2	0	3	9	91	10	0	0	63	75	**3,173**
22	**Dundalk**	155	13	4	68	18	32	114	1,074	194	152	227	166	110	166	66	329	78	100	14	1	4	12	150	16	0	0	54	154	**3,472**
23	**BWI/Glen Burnie**	5	1	0	0	44	27	8	3	13	169	8	133	11	158	19	0	0	0	0	0	8	15	0	2	0	0	9	18	**651**
24	**AA Co**	10	1	0	0	29	18	10	134	36	73	15	69	17	122	21	7	0	0	0	0	10	9	44	20	0	0	6	130	**780**
25	**Caroll Co**	0	0	0	3	0	1	2	6	13	1	14	4	26	0	0	0	0	0	0	8	2	2	2	0	0	2	87	0	**174**
26	**Harford Co**	31	1	0	0	18	8	14	411	60	127	32	236	32	213	14	76	0	0	0	0	2	16	11	0	0	0	35	1	**1,339**
27	**Howard Co**	98	11	5	31	65	36	75	906	162	69	66	79	32	121	16	28	36	38	7	0	13	16	39	5	0	0	5	274	**2,231**
28	**External**	100	10	0	5	37	18	38	813	147	93	100	69	94	171	65	67	0	0	10	1	29	17	57	8	0	0	15	0	**1,965**
Total		**2,006**	**261**	**75**	**577**	**1,275**	**689**	**2,164**	**14,863**	**3,296**	**4,664**	**1,969**	**4,993**	**1,311**	**5,022**	**840**	**1,926**	**604**	**890**	**120**	**21**	**665**	**1,052**	**1,248**	**198**	**0**	**2**	**1,182**	**2,608**	**54,521**

Markets	Summary	Percent of Total	Notes
Attractions to the CBD	9,413	29%	All Region to Districts 8 and 9
Attractions to SSA	3,183	10%	All Region to Distrcit 14
Attractions to the Bay View Medical Center	3,217	10%	All Region to District 12
Residents who live and travel in the corridor	16,642	51%	Within Corridor
Total Markets	32,455	60%	
Total Region	54,521		

Table 22 – Minutes of User Benefits per Project Trips

		District	Attractions 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total
Productions	1	NW Balt City	*	*	*	*	8	*	*	5	11	10	5	14	12	18	*	*	*	*	*	*	15	8	*	*	*	*	-2	26	11
	2	NE Balt City	*	*	*	*	*	*	*	5	-6	*	*	44	*	22	*	*	*	*	*	*	*	*	*	*	*	*	*	*	10
	3	Waverly	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	13
	4	Greenmont	*	*	*	*	*	*	*	4	-1	*	*	24	*	24	*	*	*	*	*	*	*	*	*	*	*	*	*	*	14
	5	Edmond. Vill.	9	*	*	8	*	*	9	12	11	16	9	19	*	19	14	6	3	8	*	*	*	*	8	*	*	*	11	20	12
	6	Rosemont	-5	*	*	*	*	*	0	4	6	16	7	19	*	21	*	*	*	*	*	*	*	*	4	*	*	*	20	*	8
	7	Poppleton	2	*	*	*	8	1	0	11	11	14	6	17	10	21	15	*	*	*	*	*	13	9	*	*	*	*	13	35	13
	8	CBD	*	*	*	*	2	*	*	3	15	4	*	1	*	4	*	*	*	*	*	*	*	*	*	*	*	*	*	10	5
	9	East CBD	*	*	*	*	10	*	*	39	8	14	21	13	12	18	*	*	*	*	*	*	*	5	*	*	*	*	17	27	18
	10	Canton	11	*	*	*	12	*	10	17	17	17	12	13	14	13	10	13	13	12	*	*	*	*	10	*	*	*	21	24	15
	11	S Balt City	*	*	*	*	11	*	6	6	8	12	10	16	*	20	*	*	*	*	*	*	*	12	*	*	*	*	8	*	11
	12	E Balt City	11	*	*	26	*	*	6	12	14	9	17	40	20	17	*	16	18	15	*	*	*	*	13	*	*	*	29	*	16
	13	Cantonsville	10	*	*	*	*	*	9	11	10	14	18	19	*	17	*	4	5	*	*	*	*	*	*	*	*	*	*	0	11
	14	SSA/Sec. Sqr.	11	*	*	18	12	*	9	15	14	7	16	12	7	16	*	6	10	9	*	*	*	*	10	*	*	*	*	14	13
	15	Randallstown	*	*	*	*	12	10	11	9	10	12	13	17	*	14	*	*	*	1	*	*	12	11	*	*	*	*	*	13	11
	16	Owings Mills	*	*	*	*	*	*	*	*	14	14	*	20	*	9	*	*	*	*	*	*	11	9	*	*	*	*	*	23	15
	17	Towson/Luther.	*	*	*	*	*	*	*	0	*	9	*	15	*	16	*	*	*	*	*	*	*	*	*	*	*	*	*	*	9
	18	Hunt Val./N Balt	*	*	*	*	*	*	*	*	*	8	*	15	*	14	*	*	*	*	*	*	*	*	*	*	*	*	*	*	11
	19	White Marsh	*	*	*	*	*	*	*	16	*	*	*	27	*	22	*	*	*	*	*	*	*	*	*	*	*	*	*	*	16
	20	NE Balt Co	*	*	*	*	*	*	*	20	*	*	*	21	*	18	*	*	*	*	*	*	*	*	*	*	*	*	*	4	16
	21	Essex	12	*	*	*	*	*	15	17	22	25	11	48	16	23	16	11	*	6	*	*	*	*	9	*	*	*	11	-13	15
	22	Dundalk	15	*	*	21	*	*	14	17	18	19	16	36	19	24	20	16	16	17	*	*	*	*	14	*	*	*	18	10	19
	23	BWI/Glen Burnie	*	*	*	*	*	*	*	*	*	4	*	7	*	12	*	*	*	*	*	*	*	*	*	*	*	*	*	*	7
	24	AA Co	*	*	*	*	*	*	*	17	*	17	*	21	*	20	*	*	*	*	*	*	*	*	*	*	*	*	*	6	11
	25	Caroll Co	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-1	*	22
	26	Harford Co	*	*	*	*	*	*	*	23	19	24	*	24	*	24	*	17	*	*	*	*	*	*	*	*	*	*	*	*	20
	27	Howard Co	4	*	*	*	-5	*	2	14	12	13	3	18	*	17	*	*	*	*	*	*	*	*	*	*	*	*	*	-10	8
	28	External	10	*	*	*	*	*	*	21	13	12	-6	14	-2	13	7	4	*	*	*	*	*	*	1	*	*	*	*	*	12
	Total		10	20	10	14	8	9	8	13	12	12	11	18	12	18	14	11	8	9	24	*	14	15	9	11	*	*	9	12	13

Markets	Summar		Notes
Attractions to the CBD	12		All Region to Districts 8 and 9
Attractions to SSA	18		All Region to Distrcit 14
Attractions to the Bay View Medical Center	22		All Region to District 12
Residents who live and travel in the corridor	14		Within Corridor
Average Markets	16	* - Daily Project Trips less than 50.	
Average Region	13		

4.4 Red Line LRT Ridership Volumes

Average daily ridership on the proposed Red Line LRT is 54,520. The peak period ridership represents approximately 10 percent of the estimated daily boardings or 5,370. Throughout the day and during the peak period, volumes are generally higher in the eastbound direction. The directionality of the eastbound flow is however more pronounced from the Inner Harbor Station toward the east end of the corridor to the Bayview Medical Center.

The analysis of average daily ridership at the proposed station shows the Inner Harbor Station located in the CBD area as the station with the highest level of activity (boardings and alightings), approximately 13,000 per day as seen in Table 23.

Table 23 – 2035 Daily Station Boardings

Station	Daily Boardings - On		Daily Boardings - Off		Total Boarding
	EB	WB	EB	WB	
CMS Station	1,249	0	0	771	1,010
Security Square Station	2,747	30	30	1,627	2,220
Social Security Administration Station	1,751	26	166	3,212	2,580
I-70 Park-and-Ride Station	2,905	74	34	1,230	2,120
Edmondson Village Station	1,546	174	131	442	1,150
Allendale Station	1,343	99	61	493	1,000
Rosemont Station	3,079	351	297	1,537	2,630
West Baltimore MARC Station	4,480	1,410	763	2,441	4,550
Harlem Park Station	892	270	197	217	790
Poppleton Station	304	284	703	751	1,020
Howard Street/University Center Station	2,745	2,729	5,180	4,203	7,430
Inner Harbor Station	4,879	4,130	9,690	7,165	12,930
Harbor East Station	119	831	2,481	599	2,020
Fells Point Station	187	1,142	793	298	1,210
Canton Station	164	1,370	1,117	218	1,430
Brewers Hill/Canton Crossing Station	276	5,945	1,906	206	4,170
Highlandtown/Greektown Station	14	3,176	2,106	147	2,720
Bayview Campus Station	0	871	2,519	277	1,830
Bayview MARC Station	0	2,923	504	0	1,710
Total	**28,680**	**25,840**	**28,680**	**25,830**	**54,520**

EB - Eastbound

WB - Westbound

Other stations with significant activity (boardings greater than 4,000 per day) include the following: Howard Street/University Center Station, West Baltimore MARC Station, and Brewers Hill/Canton Crossing Station. These stations provide connections to other major transit routes and access to major activity centers such as South Baltimore City, Rosemont, and the East

CBD area. The Social Security Administration and the Bayview Medical Center Station also show significant activity with station boardings greater than 1,800 per day.

Figures 11 and 12 summarize the 2035 projected daily and peak hour volumes by station and by line segment in Production/Attraction and Origin/Destination format, respectively. The Production/Attraction format is utilized in the models to better represent the characteristics of the trip maker (at their home or residence end using attributes such as household size, income, number of workers, etc.) and the trip activity at the attraction end (for example, the number and type of employment or activity). The Origin/Destination format represents the actual origin and destination of the trip or boarding/alighting of a trip regardless of the time of day or trip purpose. Throughout the day, the heaviest volumes are shown between the Fells Point, Harbor East, and Inner Harbor stations in the westbound direction and between the Harlem Park and Poppleton stations in the eastbound direction for both daily and peak period.

The peak hour maximum load point volume is the maximum number of passengers that travel past a single point on a particular transit line or route during the peak hour. The highest volume in the westbound direction is between the Fells Point, Harbor East, and Inner Harbor stations, where the trains would carry approximately 1,350 passengers during the peak period. In the eastbound direction, the point with the highest volume is between the Harlem Park and Poppleton stations. In that segment, the Red Line LRT line would carry 1,810 passengers during the peak period.

Figure 11 – 2035 LPA Daily Link Volume – Production/Attraction

Station	Direction: Eastbound	Direction: Westbound
CMS Station	1,249 1,249	771 771
Security Square Station	2,747 30 3,966	1,627 30 2,368
Social Security Administration Station	1,751 166 5,551	3,212 26 5,554
I-70 Park-and-Ride Station	2,905 34 8,422	1,230 74 6,710
Edmondson Village Station	1,546 131 9,837	442 174 6,978
Allendale Station	1,343 61 11,119	493 99 7,372
Rosemont Station	3,079 297 13,901	1,537 351 8,558

Station	Direction: Eastbound	Direction: Westbound
West Baltimore MARC Station	13,901 4,479 763 17,617	8,558 2,441 1,410 9,589
Harlem Park Station	892 197 **18,312**	217 270 9,536
Poppleton Station	304 703 17,913	751 284 10,003
Howard Street/University Center Station	2,745 5,180 15,478	4,203 2,729 11,477
Inner Harbor Station	4,878 9,690 10,666	7,166 4,130 **14,513**
Harbor East Station	119 2,481 8,304	599 831 **14,281**
Fells Point Station	187 793 7,698	298 1,142 13,437

Station	Direction: Eastbound	Direction: Westbound
Canton Station	7,698 164 1,117 6,745	13,437 218 1,370 12,285
Brewers Hill/Canton Crossing Station	276 1,906 5,115	206 5,945 6,546
Highlandtown/ Greektown Station	14 2,106 3,023	147 3,176 3,517
Bayview Campus Station	0 2,519 504	277 871 2,923
Bayview MARC Station	504	2,923

Highest Link Volumes

Figure 12 – 2035 LPA AM Peak Hour Link Volume – Origin-Destination

Station	Direction: Eastbound	Direction: Westbound
CMS Station	101	70
	101	70
Security Square Station	239	162
	2	3
	338	229
Social Security Administration Station	138	310
	17	1
	459	538
I-70 Park-and-Ride Station	267	236
	6	8
	720	766
Edmondson Village Station	141	54
	9	15
	852	805
Allendale Station	80	32
	2	6
	930	831
Rosemont Station	311	213
	30	40
	1,211	1,004

Station	Direction: Eastbound	Direction: Westbound
	1,211	1,004
West Baltimore MARC Station	596	228
	51	227
	1,756	1,005
Harlem Park Station	76	25
	25	26
	1,807	1,004
Poppleton Station	23	69
	61	30
	1,769	1,043
Howard Street/University Center Station	245	346
	453	274
	1,561	1,115
Inner Harbor Station	456	691
	1,007	461
	1,010	**1,345**
Harbor East Station	11	58
	206	59
	815	**1,344**
Fells Point Station	22	35
	67	111
	770	1,268

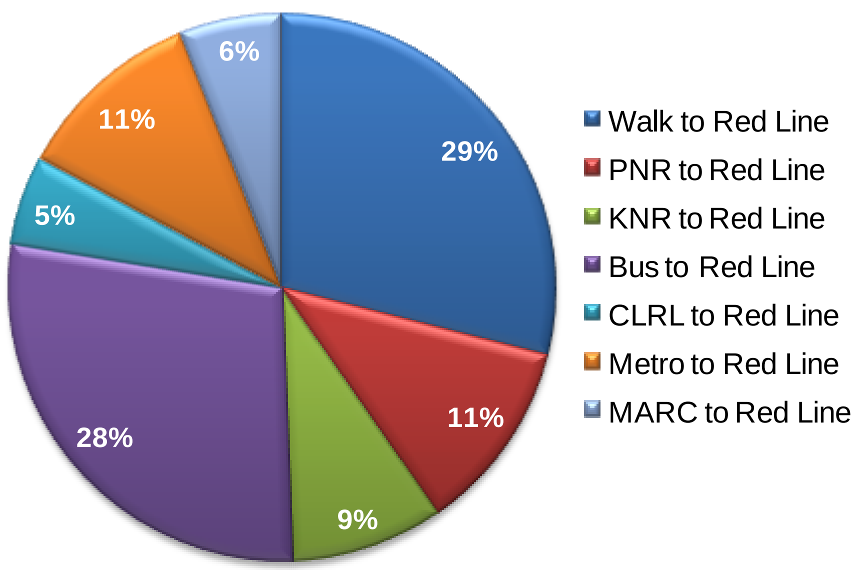
Station	Direction: Eastbound	Direction: Westbound
	770	1,268
Canton Station	12	17
	71	108
	711	1,177
Brewers Hill/Canton Crossing Station	35	22
	205	682
	541	517
Highlandtown/ Greektown Station	0	17
	282	277
	259	257
Bayview Campus Station	0	30
	189	39
	70	248
Bayview MARC Station	70	248

Highest Link Volumes

4.5 Mode of Access at Red Line Stations

With the Preferred Alternative, close to 30 percent of the transit riders would walk or take a bus to the LRT stations. Of the 20 percent who would access the LRT via automobile, 9 percent would be dropped off and 11 percent would park and ride the system. Five percent would access the LRT via commuter rail, 11 percent via Metrorail, and 6 percent via the MARC route. These statistics are illustrated in Figure 13.

Figure 13 – 2035 LPA Mode of Access



As shown in Table 24, along the Red Line, the Howard Street/University Center and the Inner Harbor stations would serve riders walking to the transit service. The highest number of riders driving to the Red Line would occur at the Brewers Hill/Canton Crossing Station, while the highest number of riders being dropped off would occur at the West Baltimore MARC Station. Highest bus access activity is estimated to occur at the Rosemont Station.

Table 24 – Light Rail Passenger Mode of Access (2035)

Station	Walk to Red Line	PNR to Red Line	KNR to Red Line	Bus to Red Line	CLRL to Red Line	Metro to Red Line	MARC to Red Line	Total On
CMS Station	1,248	-	1	-	-	-	-	**1,250**
Security Square Station	322	1,074	518	863	-	-	-	**2,780**
Social Security Administration Station	906	-	7	865	-	-	-	**1,780**
I-70 Park-and-Ride Station	-	713	455	1,811	-	-	-	**2,980**
Edmondson Village Station	1,442	-	2	273	-	-	-	**1,720**
Allendale Station	993	-	9	441	-	-	-	**1,440**
Rosemont Station	36	-	27	3,368	-	-	-	**3,430**
West Baltimore MARC Station	629	1,061	1,214	248	-	-	2,736	**5,890**
Harlem Park Station	1,100	-	3	60	-	-	-	**1,160**
Poppleton Station	416	-	48	124	-	-	-	**590**
Howard Street/University Center Station	1,690	-	404	508	2,871	-	-	**5,470**
Inner Harbor Station	1,742	-	474	731	-	6,062	-	**9,010**
Harbor East Station	950	-	1	-	-	-	-	**950**
Fells Point Station	1,267	-	4	59	-	-	-	**1,330**
Canton Station	1,534	-	1	-	-	-	-	**1,540**
Brewers Hill/Canton Crossing Station	257	2,145	996	2,824	-	-	-	**6,220**
Highlandtown/Greektown Station	360	-	87	2,743	-	-	-	**3,190**
Bayview Campus Station	871	-	-	-	-	-	-	**870**
Bayview MARC Station	22	1,218	675	441	-	-	567	**2,920**
Total	**15,790**	**6,210**	**4,930**	**15,360**	**2,870**	**6,060**	**3,300**	**54,520**
Percent Access of Total	**29%**	**11%**	**9%**	**28%**	**5%**	**11%**	**6%**	

Highest value by access mode and station.

5 UNCERTAINTY ANALYSIS

This section evaluates how some of the model input assumptions can impact ridership and the corresponding travel forecast results. Some of these assumptions include land-use as well as the highway and transit networks. A stepwise build-up approach is used to evaluate the impact of each of these assumptions, answering questions such as what would be the forecast if the Red Line was implemented today.

In addition to the stepwise build-up, a sensitivity analysis was also performed to evaluate the impact of the following considerations:

- PNR not provided at the West Baltimore Station,
- Elimination of the pedestrian tunnel at the Inner Harbor Station, and
- Reducing the peak period service headways from 7 to 10 minutes on the Red LRT line.

5.1 Stepwise Build-up

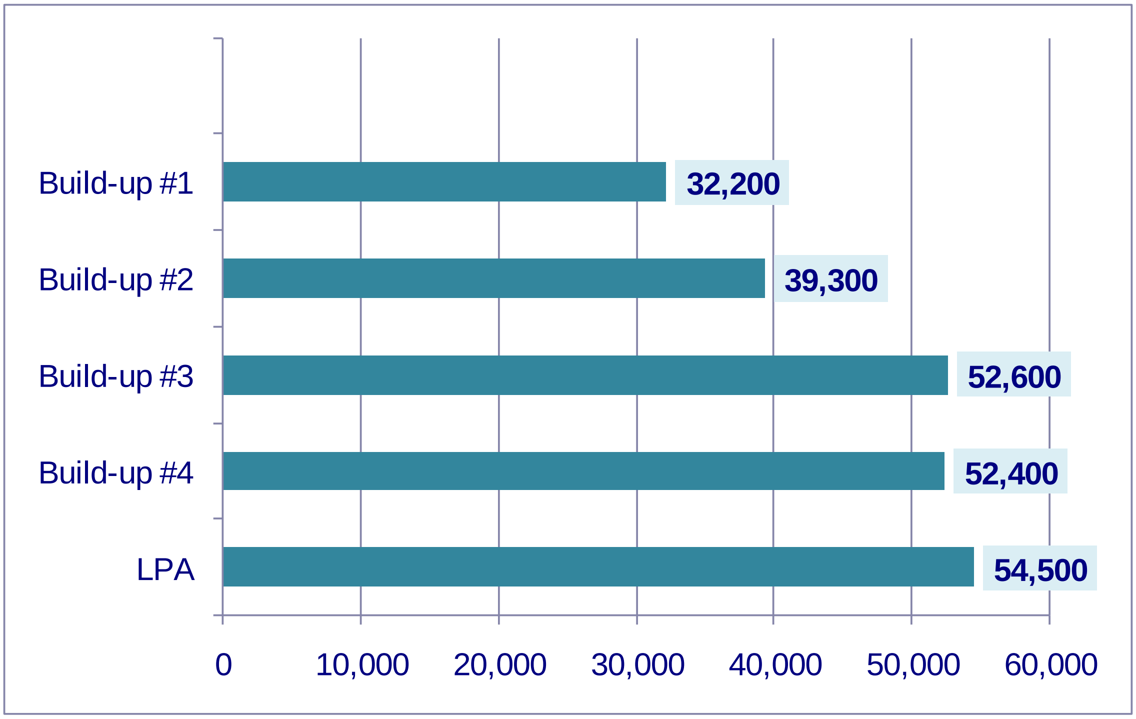
Table 25 summarizes the various scenarios tested to gain a better perspective on how growth, highway congestion, and transit service impact ridership in the Red Line Corridor.

Table 25 – Definition of the Stepwise Build-up Scenarios

Scenario	Travel Demand	Highway Speeds	Transit Speeds	Transit Network	Purpose of the Model Run
Build-up #1	*2005*	*2005*	2005	2035	To evaluate the projected ridership in 2005 if there was no consideration of the improved level-of-service, simply the existence of the LRT line. The actual 2005 on-board survey was used as the "transit demand."
Build-up #2	*2005*	*2005*	2035	2035	Compared to Build-up Scenario #1, this provides an estimate of the 2005 ridership with the level-of-service improvements provided by the LRT guideway. 2005 highway speeds and networks are used.
Build-up #3	2035	*2005*	2035	2035	Compared to Build-up Scenario #2, this estimates the impacts of anticipated person trip growth in travel demand. 2005 speeds and network are used.
Build-up #4	2035	*2005*	*2005*	2035	Compared to Build-up Scenario #3, this estimates the impacts of transit level of service on travel demand by using 2005 bus speeds along with 2035 Light Rail speeds.
LPA	2035	2035	2035	2035	Compared to Build-up Scenario #3, this estimates the impacts of highway congestion on travel demand. 2005 highway network and 2035 highway speeds are used.

Figure 14 shows the resulting average daily boardings on the Red Line for each of the scenarios analyzed. The estimated ridership ranges from 32,200 a day based on the demand from the 2005 on-board survey to 54,500 with the implementation of the LPA in 2035.

Figure 14 – Daily Boardings by Scenario



5.1.1 Opening Year Scenario

An average daily ridership of approximately 45,700 boardings is estimated on opening year scheduled for 2020. In this scenario, the highway network represents the one assumed to be in place based on the CLRTP. The transit network is identical to the 2035 LPA scenario. Because the anticipated growth is less in 2020 than in 2035, the level of congestion on the highway is less and therefore bus speeds are higher than with the LPA. The projected ridership in 2020 represents approximately 84 percent of the projected ridership on the Red Line in 2035.

5.1.2 What if the Red Line LRT Existed Today?

If the Red Line existed in the 2005 base year with the 19 proposed stations and headways of 7 and 10 minutes, peak and off-peak as assumed in the LPA, and transit ridership was taken directly from the 2005 on-board survey, the estimated average daily ridership would be 32,200 (scenario #1) per day or close to 60 percent the estimated ridership in 2035.

However, using the existing (2005) demographic data and highway network for 2005 (model base year) and the 2035 transit network that includes the Red Line (LPA), the model estimates 7,100 daily riders more than the on-board ridership level or an increase of 22 percent (scenario #2). This is a direct result of the improved level-of-service offered by the Red Line. With the Red Line in place in 2005, therefore, the system would attain over 70 percent of the 2035 forecast.

5.1.3 Growth Impacts

Red Line ridership increases by just over 13,000 riders in the 30 years between 2005 and 2035 (scenario #3). This modest level of increase is largely a result of somewhat modest population and employment growth in the corridor compared with the region, and would attain over 96 percent of the full 2035 forecast.

5.1.4 Transit Service Impacts

Using the results of Build-up Scenarios #3 and #4, there is little impact on ridership based on 2005 and 2035 bus speeds. This is consistent with the level of proposed improvements in the bus network, which remains relatively the same between the horizon years.

5.1.5 Highway Speeds and Network Impacts

Average daily ridership is estimated to increase by 5 percent assuming faster speeds on the 2005 highway network. The increase in ridership is due to faster bus service as the levels of congestion on the highway decreases.

5.2 Sensitivity Tests

The impacts of changes to design elements and service levels were also tested as part of the uncertainty analysis. Table 26 summarizes the estimated station-level and total ridership for the following scenarios:

- Absence of Park-and-Ride lot availability at the West Baltimore Station for Red Line riders.
- Elimination of the pedestrian tunnel at the Inner Harbor Station to the Town Center Metro Station.
- Reduced level of service on the Red Line LRT headway from 7 to 10 minutes during the peak period.

Table 26 – Impacts Design Elements and Service Level

Station		2035 Average Daily Boardings			
		LPA	**Without West Baltimore PNR**	**Without Pedestrian Tunnel at Inner Harbor**	**With 10-min Peak Headway on Red Line LRT**
1	CMS Station	1,010	1,000	1,000	970
2	Security Square Station	2,220	2,230	2,210	2,100
3	Social Security Administration Station	2,580	2,540	2,510	2,390
4	I-70 Park-and-Ride Station	2,120	2,170	2,070	1,990
5	Edmondson Village Station	1,150	1,140	1,110	1,090
6	Allendale Station	1,000	1,010	900	940
7	Rosemont Station	2,630	2,620	2,530	2,310
8	West Baltimore MARC Station	4,550	3,420	4,340	4,020
9	Harlem Park Station	790	780	680	650
10	Poppleton Station	1,020	990	960	890
11	Howard Street/University Center Station	7,430	7,520	8,580	6,900
12	Inner Harbor Station	12,930	12,730	9,950	11,770
13	Harbor East Station	2,020	2,010	1,960	1,920
14	Fells Point Station	1,210	1,200	1,320	1,100
15	Canton Station	1,430	1,430	1,380	1,400
16	Brewers Hill/Canton Crossing Station	4,170	4,190	4,200	4,030
17	Highlandtown/Greektown Station	2,720	2,720	2,450	2,440
18	Bayview Campus Station	1,830	1,830	1,840	1,820
19	Bayview MARC Station	1,710	1,720	1,630	1,560
Total		**54,520**	**53,250**	**51,620**	**50,290**

5.2.1 West Baltimore PNR

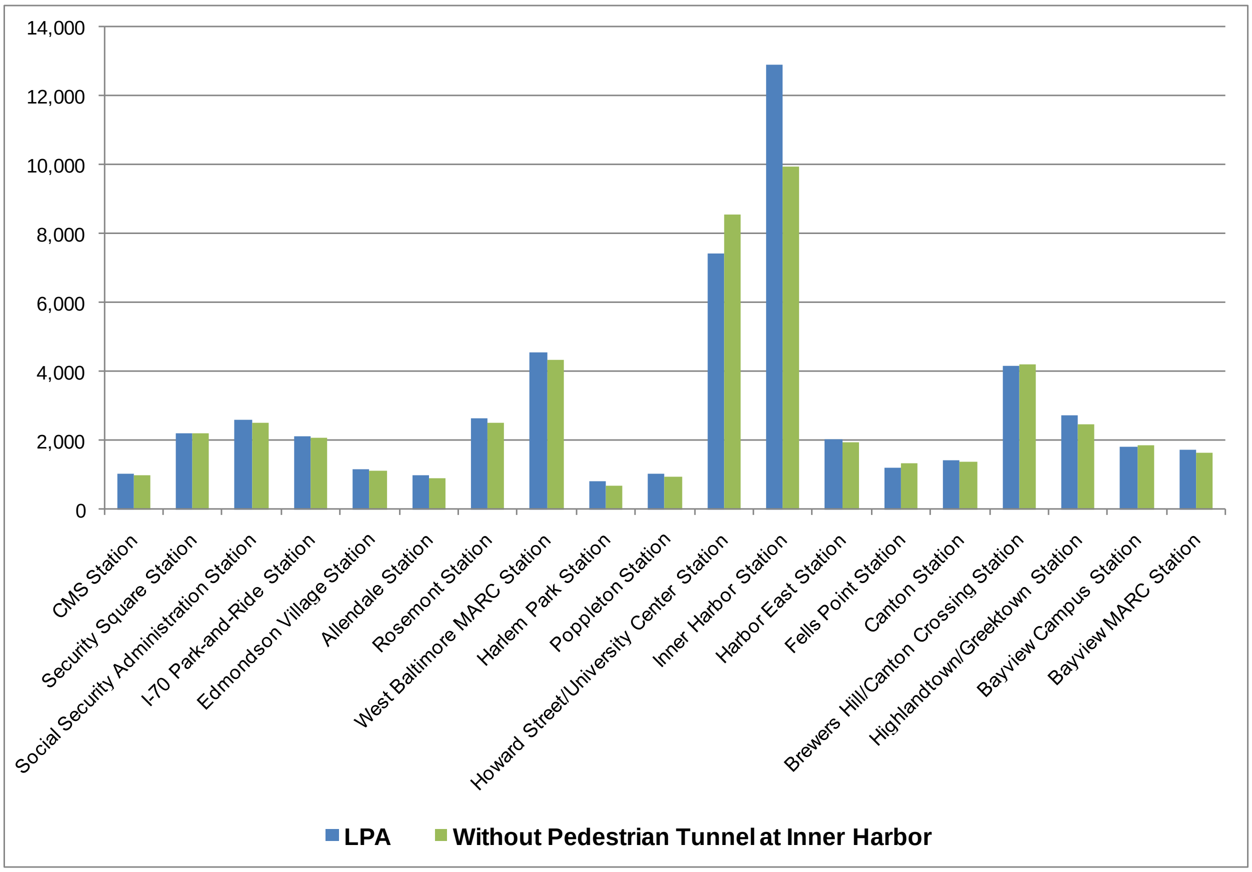
In the LPA, the West Baltimore park-and-ride facility has capacity for 800 vehicles. Without the park-and-ride facility for Red Line riders, average daily boardings on the Red Line LRT are estimated to decrease by 1,270 riders, a 2.3 percent difference from the LPA. As expected, ridership at the West Baltimore Station is the most impacted with a decrease of 1,130 boardings per day. The assumption underlying this test stems from the likelihood that MARC riders would fill all of the spaces much earlier in the morning.

5.2.2 Inner Harbor Pedestrian Tunnel

The pedestrian tunnel at the Inner Harbor Station provides a direct connection between the Red Line and the Metro. The estimated ridership in Table 26 shows that elimination of this facility would decrease the estimated LPA average daily boardings by approximately 5 percent or 2,900 boardings per day. As shown in Figure 15, the stations most impacted are–

- The Inner Harbor Station with a decrease of 2,980 boardings.
- The Howard Street/University Center Station with an increase of 1,150 boardings as riders shift to other stations.

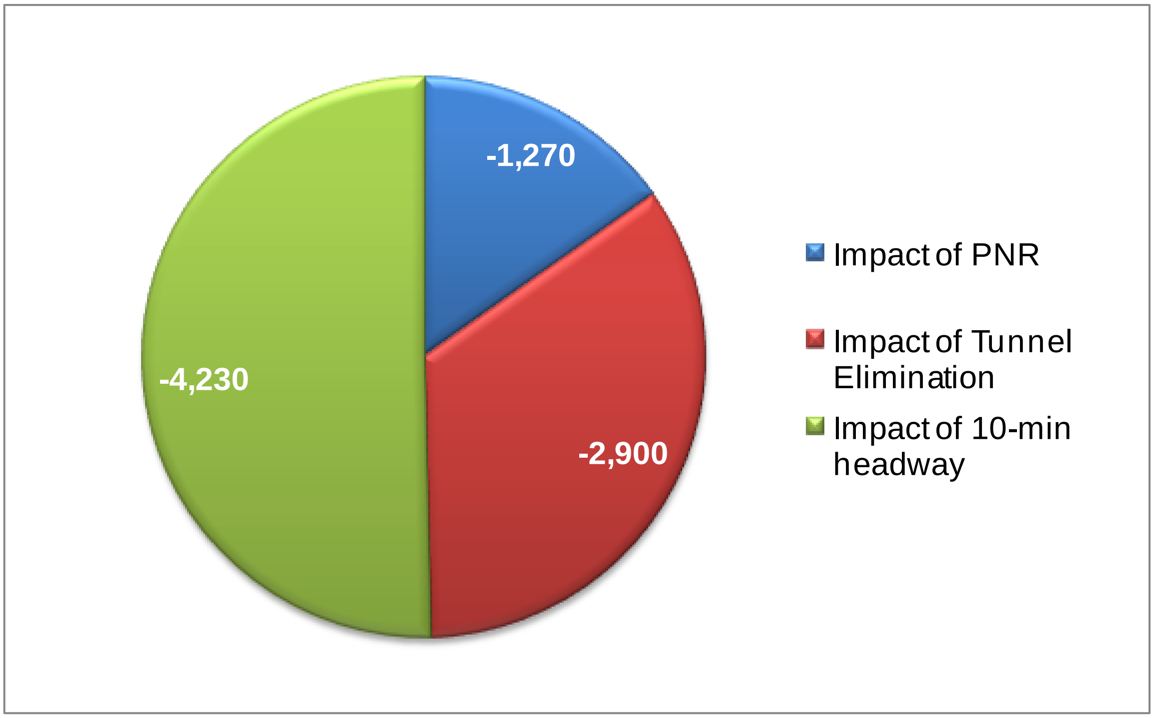
Figure 15 – 2035 Daily Boardings without Pedestrian Tunnel at Inner Harbor Station



5.2.3 Peak Period Level of Service

Reduction of the peak hour service from 7 to 10 minutes has the most impact on average daily ridership on the Red Line LRT. As seen in Figure 16, the reduction in service decreases the estimated LPA ridership by 8 percent or approximately 4,230 boardings. This is a significant impact since the average ridership during the peak period under the LPA is approximately 10 percent of the daily estimates.

Figure 16 – Level of Service Impact



5.3 Summary

Analysis of the travel forecast results of the Stepwise Build-up and the sensitivity tests can be summarized as follows:

- Estimated ridership if the Red Line LRT was in service today is 32,200 or 60 percent the estimated average daily ridership in 2035.
- The projected increase in population and employment by 2035 accounts for close to a 33 percent increase in projected ridership with the Red Line LRT.
- Highway and bus transit speeds and network assumptions impact ridership by approximately 5 percent.
- The absence of the Park-and-Ride lot parking spaces for Red Line riders at the West Baltimore Station would decrease estimated average daily ridership on the Red Line by 2.3 percent, or 1,130 boardings.
- Elimination of the pedestrian tunnel at the Inner Harbor Station would decrease ridership by 5 percent, or 2,900 boardings per day.
- Reduced level of service on the Red Line LRT from 7 to 10 minutes during the peak period is estimated to decrease average daily ridership on the Red Line by 8 percent, approximately 4,230 riders per day.